California Forest Experiment Station

UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

R
Supervision
Advisory Council

February 4, 1929

REPORT ON MEETING OF THE

ADVISORY COUNCIL

CALIFORNIA FOREST EXPERIMENT STATION

February 4, 1929

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PROGRAM

CALIFORNIA FOREST RESEARCH ADVISORY COUNCIL

February 4, 1929

Report - California Forest Experiment Station
Director Kotok

Experimental Forest for Fire Studies
District Forester Show

National and State Forest Problems
Major R. Y. Stuart
Forester, U. S. Forest Service

Financial Reports
Federal - C. G. Dunwoody, California Development Assn.
State - M. B. Pratt, State Forester
County - Francis Cuttle, Tri-Counties Reforestation Com.

Lunch

Erosion and Watershed Studies, W. C. Lowdermilk

Problems in Southern California, C. J. Kraebel

Management Studies in the Pine Region, D. Dunning

Entomological Studies, H. L. Person

Products and Utilization, C. L. Hill

Discussion and Recommendations

EXPERIMENT STATION
FILE COPY

RS
Supervision
Advisory Council

January 28, 1929

Statement for Advisory Council of the California Forest Experiment Station

The following is a brief review of the year's work and the present status of each project. It is prepared in anticipation of the Annual Meeting of the Council, February 4, 1929, in San Francisco.

FINANCIAL STATEMENT

(Fiscal Year 1929)

Income

Federal Appropriations -		
Silvicultural Investigations	$ 33,560.00	
Products	11,950.00	
State Appropriations	10,000.00	
Southern California Agencies	5,920.00	61,430.00

Distribution of Expenditures

Salaries Technical Staff	35,190.00	
Salaries Clerical	7,080.00	
Travel Expenditures	8,425.00	
Labor, field assistants, laboratory assistants	5,400.00	
Equipment, Supplies, Instruments, Structures, Telephone, Telegraph, Freight, Express, Etc	5,335.00	61,430.00

ESTIMATED DISTRIBUTION OF EXPENDITURES BY PROJECTS

Forestation	7,860.00	
Fire	2,630.00	
Type Map	13,390.00	
Forest Influences	12,770.00	
Management Studies	12,330.00	
Products and Utilization	11,950.00	
Special Studies (Cooperation with Extension Forester)	500.00	61,430.00

Personnel

Director) Fire)	-	E. I. Kotok
Products	-	C. L. Hill M. R. Brundage I. J. Mason
Forest Management and Reforestation	-	(Duncan Dunning (~~H. W. Siggins~~ A. A. Hasel (R. B. Weaver (Feather River ~~(Vacancy)~~ E. A. Morrow
Forest Influences	-	(C. J. Kraebel (W. C. Lowdermilk
Cover Type	-	(A. E. Wieslander (R. C. Clar (Assigned by State Forester)
Cooperating Bureaus:		
Entomology	-	H. L. Person
Biology	-	E. E. Horn
Clerks	-	(D. H. Vinther (F. M. Towle (L. O. Baxter (~~I. F. Boyer~~ Kerri
Field Assistants and Computers	-	~~8~~ 26 (Part time) F. Shuchat
Day Laborers	-	2

Forest Management Studies in the Pine Belt

1. Methods of Cutting

Purpose. The methods of cutting studies furnish a basis for developing management and silvicultural practices on the national forests. (Such data will also be indespensible for the application of forestry to private lands.) The information is secured from permanent sample plots representing typical methods of cutting in the national forests in stands of varying composition under different conditions, timber sale inventories, and examinations of private cuttings.

Status. Thirty sample plots located on the Lassen, Shasta, Plumas, Tahoe, Stanislaus, Sierra, and Sequoia national forests. Plots examined annually and completely remeasured every five years.

Results. Bulletin published on results of ten years' observation; a Tree Selection scheme published, which has been incorporated in Forest Service marking rules in timber sales. Results used in public requirements bulletin and in management plans. Manuscript now in preparation giving results of fifteen years' observations on these plots.

Future Plans. Establish two new plots in sugar pine-fir type, two new plots on east side western yellow pine.

2. Natural Reproduction

Purpose. To determine the major factors controlling seed bearing, seed distribution, germination, and survival of natural seedlings as they affect silviculture, grazing and protection.

Status. Data obtained on the growth and survival of advance growth and progress of restocking of timber sales. Data obtained on seed crops and seed bearing of different tree types on permanent sample plots. Special experiments under way on the Stanislaus National Forest to determine effect of removal of litter, competition from bear clover, and losses through rodents.

Future Plans. Continue studies in various timber types.

3. Project

Thinning studies in even-aged second growth stands of sugar pine-white fir, western yellow pine, Douglas fir, and white fir.

Purpose. To determine what spacing and tree class distribution at different ages for different species and sites will produce the largest volume of the quality of timber desired. Although thinnings are impracticable at present, the long time element involved justifies starting such work on a small scale.

Status. Twenty-two plots established: two in 1912, eight in 1919, six in 1920, two in 1921, four in 1927.

Results. Progress reports for early plots completed.

Plans. No further plots to be established for the present. Remeasurement of plots every five years.

4. Slash Disposal

Purpose. To compare piling and burning of all logging slash with disposal of slash only on strips. Effect to be studied from standpoint of costs, fire control, and natural reproduction.

Status. Two experimental areas, one on the Stanislaus and one on the Lassen National Forests under observation. This work in cooperation with Pathologist from Bureau of Plant Industry. Additional information secured from methods of cutting plots.

Future Plans. Continue observations and prepare report when sufficient data available.

5. Yields

Purpose. To determine yields at different ages in even-aged stands of timber for different types and sites.

Status. 655 temporary sample plots measured, 13 permanent sample plots established and measured.

Results. Tentative yield tables or expected growth at different ages have been constructed for western yellow pine on the east and west slopes of the Sierra. Tables have been prepared for Douglas fir, white fir, and red fir by the University of California, toward which the Experiment Station has contributed a small amount of data.

Future Plans. Remeasure permanent plots every five years. Some more new plots should be established. Tentative yield tables for mixed stands to be prepared. Modern tables for western yellow pine to be constructed.

Fire Studies

1. Fire Damage

Purpose. To determine damage caused by repeated summer fires on forests, restocking brushfields, and chaparral.

Status. Permanent sample plots established since 1920, several large fires cruised and damage appraised.

Results. In part used in publication "Role of Fire in the California Pine Region".

Future Plans. Reexamine plots established and set out a few more plots.

2. Rating of Hazard

Purpose. From a study of the records of all fires on the national forests determine the relationships of various types to occurrence of fires, rate of spread, and the efficiency of measures of control.

Status. One circular "Forest Fires in California", a study of fires from 1911 to 1920, published and results applied to national forest administration. A manuscript dealing with the cover type as a factor in fire control now in the hands of printer.

Future Plans. Analysis of fires from 1921 to 1926 will be made this winter for publication as a Government bulletin.

3. Study of Going Fires

Purpose. Preliminary studies by Administrative Officer of the Forest Service and the Special Boards of Fire Review have clearly shown great diversity of methods in strategy and tactics in the handling of fires. One purpose of the study is to check on the grounds methods of strategy and tactics in relation to humidity, wind, cover and topography. An additional purpose is the development of a sound technique in measuring and evaluating the major factors which influence spread of fires and their suppression.

Status. Valuable data have already been collected by the Boards of Fire Review in 1924 and 1926, which can be correlated with the study.

Plans. A minimum of two or three going fires will be studied and the following factors will be considered:

1. Meteorological - Several stations will be established around and as close to the fire as possible. Humidity, wind movement and temperatures will be taken.
2. Rate of spread - The successive stages of the spread of the fire will be mapped, showing character of cover and time of spread.
3. Topography - A topographic map will be prepared after the fire.
4. Cover types and fuel - A type map showing these will be made.
5. Suppression methods - Every line built, every natural barrier will be shown together with its width, depth, closeness to fire, time of construction, etc. Every break will be analyzed.
6. Conclusions - All the data will then be assembled and studied.

4. Study of Lightning Fires

Purpose. To determine the lightning zones, and methods for predicting lightning storms that set forest fires.

Status. Records at Lookout points have been gathered since 1925. Some preliminary papers published.

Future Plans. Continue collection data and in cooperation with Weather Bureau analyze data.

5. Controlled Burning

Purpose. To test whether annual light burning could ever be successfully carried on within the timber belt proper in the virgin forest; and to determine the ultimate effectsof the treatment.

Status. A 200 acre area on the Plumas National Forest was first light burned in 1919. A burn was attempted practically every year during the life of the experiment and only 5 burns in 9 years were possible.

Results. The results conclusively prove that it is impossible to light-burn annually covering the entire area. If the south slope burns as desired the north slope fails to carry fire. Where fire burns the litter the inevitable destruction of the new seedlings and the damage to older reproduction may be expected. Losses by undercutting of previously scarred trees and by insects continue. Costs are prohibitive.

Future Plans. The results of this study will be published in the near future. This experiment is closed.

6. To Determine Relationships Between Weather and Fuels

Status. Collection of data on wind movement begun in 1913, on evaporation in 1920, and on humidity in 1924. Results to end of 1923 published as U.S.D.A. Circular 354, "Weather Conditions and Forest Fires in California". Observations continued during 1925, 1926, 1927, and 1928.

Plans. Continue data on evaporation and relative humidity. Extend to temperature and precipitation as rapidly as possible. Continue cooperation with Weather Bureau. Completion indefinite.

7. Study of Fire Breaks and Fire Lines

Purpose. To determine the best location of firebreaks and fire lines, the most effective width and use in controlling going fires.

Status. Many miles of fire breaks have been built in southern California. A fire line system was begun along the Sierra and Sequoia in 1912. Construction of new fire line is now proceeding on a large scale in the south. The data as to the cost and effectiveness of such lines have never been collected or correlated.

Plans. The history of all fire breaks in southern California and the Sierras will be gone into; their effectiveness on actual fire control will be studied from the records of past fires, etc.

Forest Influence Studies

1. Relation of Brush Cover to Streamflow and Erosion.

Purpose. To ascertain the extent to which brush cover in California affects the amount and control of streamflow and erosion.

Status. Experiments were installed during 1927 at Devil Canyon, San Bernardino N.F. consisting of (1) the Barranca Burn, and (2) superficial run-off and erosion plots. Barranca Canyon is mapped, and is equipped with rain gages, with a sediment catchment reservoir, and with instruments and set up to measure streamflow as it enters the sediment reservoir. Vegetative succession quadrats were established over the watershed and readings and mapping were done so as to follow the degree and rate of recovery of the brush cover after fire and to follow the course of natural control of erosion and the corresponding effect on run-off.

Four superficial run-off and erosion plots in duplicate, each with an area of 1,000 square feet were established. One pair was burned off to contrast with the other pair covered with brush. The plots were equipped with self recording special tipping bucket instruments to correlate rate of superficial run-off and erosion to the intensity of rainfall. Records for one rainy season have been collected for these two set-ups. In cooperation with the University of California special run-off plots and run-off tanks have been installed to measure the comparative superficial run-off and erosion of falling rain on type soils where forest litter and humus are retained and where burned.

Plans. Barranca Canyon installation is to be maintained and the sediment reservoir is to be waterproofed. A second series of superficial run-off and erosion plots will be established. Four similar small canyons are to be hunted up suitable for the installation of a stream flow experiment in duplicate.

Results. Preliminary results will be published this winter.

Forestation in the California Pine Region

1. Nursery Practice

Purpose. To determine the nursery practices which will produce with greatest economy of land, labor and water, the kinds of native coniferous stock best suited to outplanting in the California pine region.

Status. Work carried on at the Feather River Nursery from 1913 to 1917 has been summarized in a Government bulletin now in process of publication. Supplementary experiments begun in 1927.

Future Plans. Further work will be done this year in determining the amount of water needed in the seedbeds and means of improving the top-root balance of stock. A study of soils best suited to produce optimum size and balance in 2 year old stock will be begun.

2. Outplanting.

Purpose. To find methods of planting coniferous stock which will make reforestation in the California pine region physically and economically possible.

Status. Work carried on from 1907 to 1917 in brush fields and on burned areas has been summarized in a Government bulletin now in process of publication. Additional plantations established in 1927.

Future Plans. Continued plantings to determine the effect of season of planting, artificial protection of the planted tree, and removal of competing vegetation by fire, logging, or deliberate clearing will be made in 1929.

FOREST PRODUCTS

These studies are aimed primarily at the reduction of waste in lumber production and consumption, the analysis of marketing and other economic factors, including gathering of statistics. These contribute toward both the conservation of timber supply, as a national problem, and toward increasing the present unsatisfactory realization of the lumber industry, which constitutes one of the chief obstacles to the practice of constructive forestry by this industry.

1. Lumber Seasoning Stains

Purpose. Study of these stains, which cause heavy damage in California pine lumber, and of various means for their prevention, in cooperation with Office of Forest Pathology, U. S. Bureau of Plant Industry, the Sugar Pine Lumber Company and manufacturers of various chemical preparations.

Status. Carried on for past two years. About 400 M feet of lumber, part dipped and part controls (undipped), piled and under observation. About 100 M feet taken down and results analysed for progress report prepared in 1928. Chemicals used are Fungimors, a German product, Nekyan, a Swedish product, and several new compounds prepared by Du Pont and other American firms.

Future Plans. Remaining piles regularly inspected and will be taken down next spring. Several million data records will be analysed and report prepared. Expected to be finished in 1929.

Results. Fungimors, from 1927 piles, appears to be much more effective than soda dips heretofore chiefly used in the United States; but several problems remain to be answered by 1928 piles, respecting concentration of chemical and most practically feasible methods of application. Other chemicals included in 1928 work, still to be completed and analysed.

2. White fir.

Purpose. To determine the present stands, production, degree of utilization, and present and possible uses for white fir, with a view to increasing its economic value.

Status. Studies of methods of production and of quantities and grades produced at mills and sold at retail yards, with factors affecting marketing and use of this species concluded and office report for this region completed.

Plans. Trade magazine articles on this species will be released on completion of certain further technical studies at the Forest Products Laboratory. General bulletin on these species throughout the Pacific Coast and Inland Empire region will be prepared at Forest Products Laboratory with collaboration of regional Products organizations.

Results. Very promising prospects seem to be indicated that by better production and seasoning practice the realization from lumber of this species can be increased by more than the cost of the better practice, through a better product and satisfied purchasers. Correlation of paper manufacture with that of lumber, when feasible would undoubtedly materially better the realization from white fir.

3. Lumber depreciation

Purpose. To work into a correlated whole, data on lumber depreciation from all causes, accumulated in detached studies during past years, so as to afford a consistent basis for National Forest timber appraisals and studies for bettering economic returns to the lumber industry.

Status. Urgently needed for several years past, but could not be carried out for lack of man-power. Begun this year.

Plans. Will be completed as far as possible before the opening of the coming field season.

Results. Too early to state specific conclusions.

4. Heptane

Purpose. To determine the best practices in tapping Jeffrey pine for heptane, which is a peculiar product yielded by the oleoresin of this tree instead of the terpenes yielded by most pines. The criterion of best practice is its effect upon the yield, cost and quality of product and upon the health and growth of the timber stand.

Status. Report prepared in 1928 on experimental work carried on in 1927. Field work also continued 1928.

Plans. Report on 1928 field work will be completed. Whether field work will be continued is uncertain pending decision whether more heptane will be contracted for by Ethyl Gasoline Corporation of New York, for whom the commercial extraction is being carried on.

Results. Thus far a considerable number of interesting and valuable conclusions has been indicated having a material bearing upon the conduct of the operation, to which they are now being applied. A technical paper has been pre-

pared for publication, and a more popular one will be prepared for lumber and naval stores periodicals.

5. California Economic Research Council

Purpose. Participation in the work of this Council through Mr. Hill as member of Executive Committee and Chairman of Standing Committee on Natural Resources, for the furtherance of research in the field of natural resources, with a view particularly to its value in connection with problems of the forest resource.

Status. During the past year attention has been directed to projects for the speeding up of the issuance of soil survey results by the federal Bureau of Chemistry and Soils; the issuance of a climatic handbook for California; the extension and correlation under State supervision of snow surveys in California; the speeding up of completion of the base-map network for California, with special reference to vertical control; and the forwarding of plans for an ultimate land use survey and classification for this State.

Results. Through California Council action and that in other states inspired by it, Congressional appropriation was secured for the soils work desired. Through the State Division of Water Rights the power, irrigation and other interests concerned with snow surveys were canvassed, a conference of such agencies held at Sacramento and appropriate legislation introduced into the State legislature which it is hoped will result in undertaking of this work. Council approval was obtained for the base map and land use projects and further action is in progress.

Plans. A conference similar to that on snow surveys is planned for next month on the base map project, which it is hoped will result in a voluntary Coordination Committee, and necessary legislation enabling State cooperation with the U.S.G.S. and other agencies to speed up this map work. Plans for the climatic handbook are under negotiation with the Agricultural Department of the University of California.

6. Statistical

Under this head are included the taking of the annual lumber and timber products census for California and Nevada, for and in cooperation with the U. S. Census Bureau; with which goes the collecting of data on lumber distribution from California to other states and foreign countries, and on current stumpage prices; and the collection of data on current wholesale lumber prices.

Purpose. The object of these studies is to collect the data necessary to the industry and for statistical use generally in studies of lumber and timber economics.

Plans. These are all continuing projects, not likely to be discontinued inasmuch as the Forest Service is able to secure both cheaper conduct of these inquiries because of its permanent local personnel, and more accurate statistical results because of its familiarity with regional lumber conditions and practice.

Entomological Studies

1. Biological control studies

Purpose. To develop methods of control by means of natural enemies of the bark beetles.

Status. Abundance and habits of important insect enemies of bark beetles studied.

Plans. Study of methods for practical use of certain beneficial predators.

2. Tree Selection

Purpose. To determine characteristics of most susceptible trees so that they can be removed in first cut; also what attracts beetles to certain trees.

Status. General characteristics of beetle selected trees determined, also chemotropic basis for selection.

Plans. To determine nature of attractive substance and why it is present only in certain trees.

3. Factors affecting barkbeetle infestations

Purpose. Study of effects of climate, fires and slash on ~~insect population under~~ increase and decline of infestations.

Status. Relation of above factors being studies on a number of permanent sample areas.

Results. Reports completed on effect of drought, fires, and slash on insect population under certain conditions.

ADVISORY COUNCIL, CALIFORNIA FOREST EXPERIMENT STATION
MINUTES OF MEETING, HOTEL WHITCOMB, SAN FRANCISCO

February 4, 1929

Meeting called to order by President Ray Lyman Wilbur at 10:30 a.m. Members present were:

Dr. Ray Lyman Wilbur, President of the Council
Swift Berry
Dr. E. E. Brownell
Dr. W. W. Campbell
Francis Cuttle
Charles G. Dunwoody
A. C. Hardison
B. A. McAllaster
Duncan McDuffie
Prof. Walter Mulford
M. B. Pratt
D. H. Steinmetz
Spence D. Turner
Willis J. Walker
S. B. Show, District Forester, Ex-Officio Member
Director E. I. Kotok, Secretary of the Council

Of those absent, H. S. Gilman was represented by Judge Harold Cusanne.

Other Council members absent were:

F. H. Fowler
C. R. Johnson
E. W. Murphy
A. Stanwood Murphy
H. M. Robinson
I. Zellerbach

Invited guests present were:

Chief Forester, R. Y. Stuart of the U. S. Forest Service
S. R. Black
Robert L. Deering
T. D. Woodbury
J. H. Price
W. I. Hutchinson

Director F. C. Stevenot, of the State Department of Natural Resources, sent the following telegram, regretting his inability to be present:

"Ray Lyman Wilbur
Delr personally at meeting report delivery Chairman Advisory Council California Forestry Experimental Station Hotel Whitcomb.

"Regret owing to attack of flu am unable to attend Advisory Council meeting today stop My disappointment is aggrieved by inability to join with Council in giving recognition to Major Stuart and his fine leadership in Federal forestry matters in California stop Please convey to him and his associates also to those interested and in attendance at your meeting my pledge of whole-hearted cooperation in support of measures deemed necessary to bring about an effective forestry program an important feature of which must necessarily provide for adequate support of California's experimental station in order that we may thoroughly understand through skilled research and practical field investigations the basic problems involved in forestry in our State stop Every activity of the Department of Natural Resources is fundamentally dependent on the carrying out of a vigorous forestry policy in California.- Fred C. Stevenot, Director of the Department of Natural Resources."

The report of the Station's work for the year was presented by Director Kotok.

On motion of Mr. Cuttle, seconded and passed, the report was received and approved by the Council.

Consideration of the recommendations presented in the report was postponed for inclusion with that of finances and future plans.

District Forester Show then addressed the Council in respect to his proposal for the establishment of an experimental fire forest, urging the participation of the Experiment Station in the project and the concentration of the Station's fire studies on that area. A summary of Mr. Show's remarks is separately provided for Council record. He requested specifically the following Council action:

1. Approval of the fire study project as such.
2. Recommendation to the Administrative Officers of the Forest Service of serious consideration of the project.
3. Recommendation that the Experiment Station cooperate in the research aspects of the project, concentrating their fire research activities within the proposed experimental forest.

After some discussion Mr. Show's recommendations were approved by unanimous vote.

Chief Forester Stuart then made a brief talk, of which separate abstract will be provided.

Attention was then turned to discussions by Experiment Station staff members of some of the important lines of Station work. The subject of forest influences upon the water cycle, or the relation between rainfall, run-off, seepage, and erosion was presented by W. C. Lowdermilk. C. J. Kraebel discussed the work at Devil Canyon and the Barranca Burn.

On motion of Mr. Cuttle, the Council requested that the statements of the staff workers in respect to their lines of work be furnished to Council members in written form for their future reference.

At the afternoon session, staff statements were continued, in the following order:

Forest management and silvics, by Duncan Dunning.

Bark-beetle control, by Consulting Forest Entomologist H. L. Person.

Blue stain control and woods and mill studies, by C. L. Hill, Forester in Charge of Forest Products Investigations.

Attention was then turned to the financial reports presented by the following Council members.

Federal funds, by Charles G. Dunwoody,
State funds " M. B. Pratt.
County funds " Francis Cuttle.

These reports were accepted by the Council.

Director Kotok then presented a list of matters on which he desired Council action, by resolution or otherwise, as follows:

1. That in view of the great importance of research on fire and forest influences in our program, any increased appropriation received by the Station for the coming year should be allotted to these projects and divided 50-50 between them.

2. That in view of the necessity of good topographic base maps for practically all Station projects and especially to the cover type map, which is being severely handicapped by the lack of such maps, the Council as a whole and individually lends its weight to the furtherance of progress in completing the base map network for this State.

3. That the Council approve the combined woods and mill studies such as are now under negotiation by the Station, with a view to the correlation of desirable measures in silviculture with logging and milling practice.

4. That the Council recommends increased proportionate appropriations for the Bureau of Entomology for fundamental research as against practical control operations.

5. That the Council approves a request to the Biological Survey that its representative assigned cooperatively to the Experiment Station be permitted to spend more time on fundamental research in the relation of forest animal life to cutting and other forest management measures, and that he be relieved of such rodent control administrative responsibility as is possible to permit the research requested.

6. That the Council approve the calling of a conference in southern California of engineers and foresters for the mutual discussion of water and forest relations and the research which is most needed in that connection.

The above items were all approved by Council vote.

On suggestion of Director Kotok the Council agreed to the appointment by President Wilbur of Council committees for special consideration of the subjects of finance; mapping; a proposed conference of foresters and engineers on the Station forest influence program; fire studies; silvicultural management studies; and products and utilization.

Adjourned at 3:00 p. m.

E. I. KOTOK,

Secretary.

CALIFORNIA FOREST EXPERIMENT STATION

E. I. Kotok, Director

In last year's report a brief history of the establishment of the Station, its development and its program of work was outlined. A review of the program by this Council indicated that no major deviations were possible in going projects unless increased appropriations became available, and with increased appropriations any expansion should give first consideration to economic studies, forest influences, and fire studies. Present indications are that the Federal appropriations for the Station, in spite of the efforts made in California, will remain substantially the same, although the latest reports indicate a possible $20,000 increase. We are promised an increase in the State budget of $2500 a year; likewise, there are possibilities that funds from various counties in southern California may be increased. The above State increase and any expected additions from southern California will be merely sufficient to maintain going projects without any elaborate expansion.

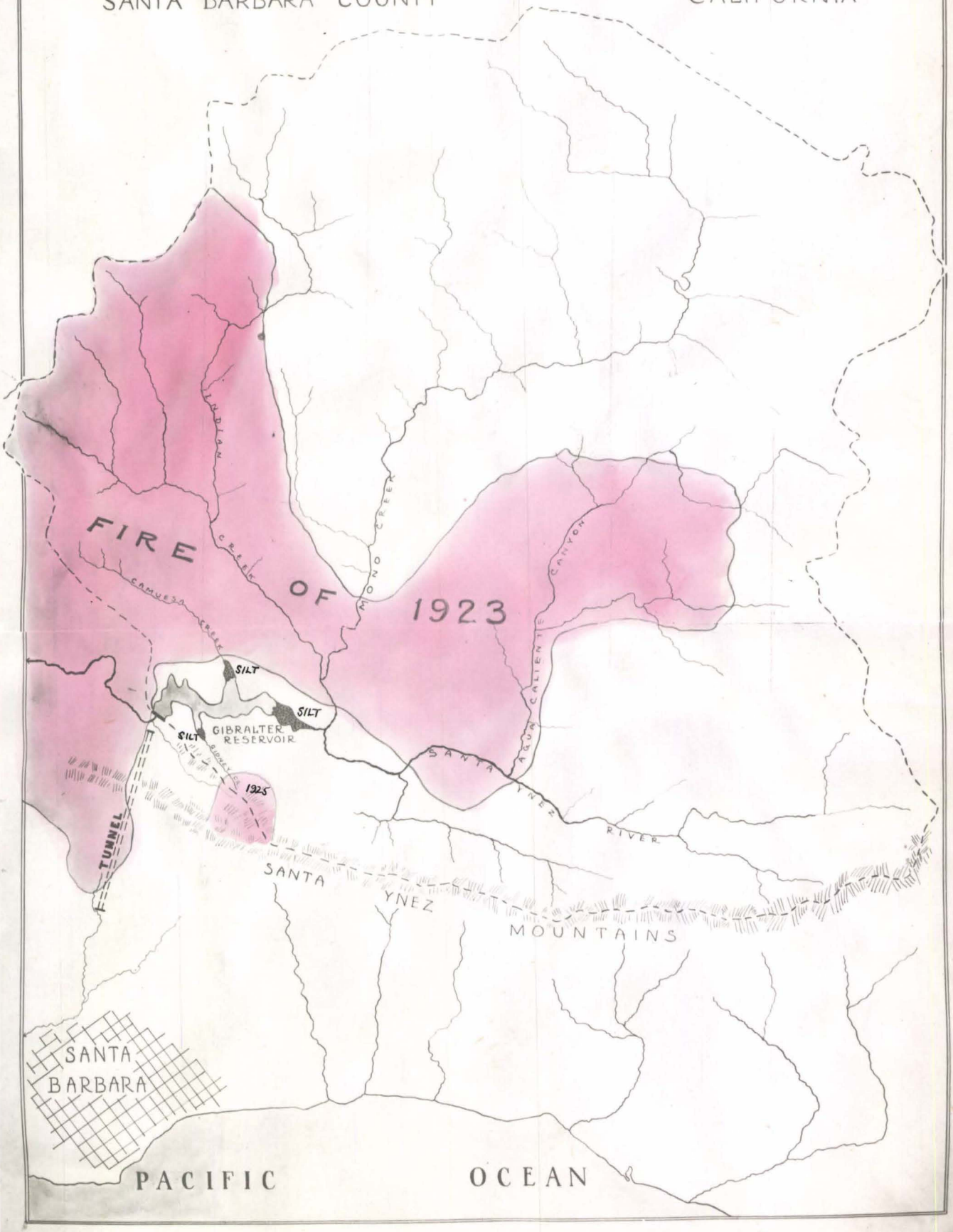
At this time I should like to touch on the present program of the Station, in the light of the more pressing problems confronting forestry in California, and consider how far we are supplying the facts essential to the solution of these problems.

A resume of the projects of the Station, giving the present status and future plans for each has already been forwarded to each member of the Council.

Last year we considered briefly the relationship of forest and wild lands of this state to our water resources. No more vital question confronts us than this. We have made a beginning in the forest influence studies, and can report some progress. The cooperative study with the University of California has passed one stage; the importance of humus and litter in fixing soil and preventing erosion, in reducing superficial run-off, and increasing the water holding capacities of the soil itself, has been quantitatively determined for three characteristic soil types. The interesting details of this study will be presented later today.

The importance of a vegetative cover, and its effect on the development of a State-wide plan of irrigation and hydro-electric development has not been generally recognized and frequently has been left entirely out of the calculations in the planning for and maintenance of these costly projects. I want to take this opportunity of describing two current instances of this important relationship, one located in the northern part of the State, the other in the south. The first illustration deals with the Gibralter Dam, a reservoir constructed a few years ago for the storage of water for the City of Santa Barbara. As a result of one serious fire on this watershed, heavy silting has taken place, and

GIBRALTER RESERVOIR
AND
CONTRIBUTING WATERSHED
SANTA BARBARA COUNTY CALIFORNIA



SKETCH MAP

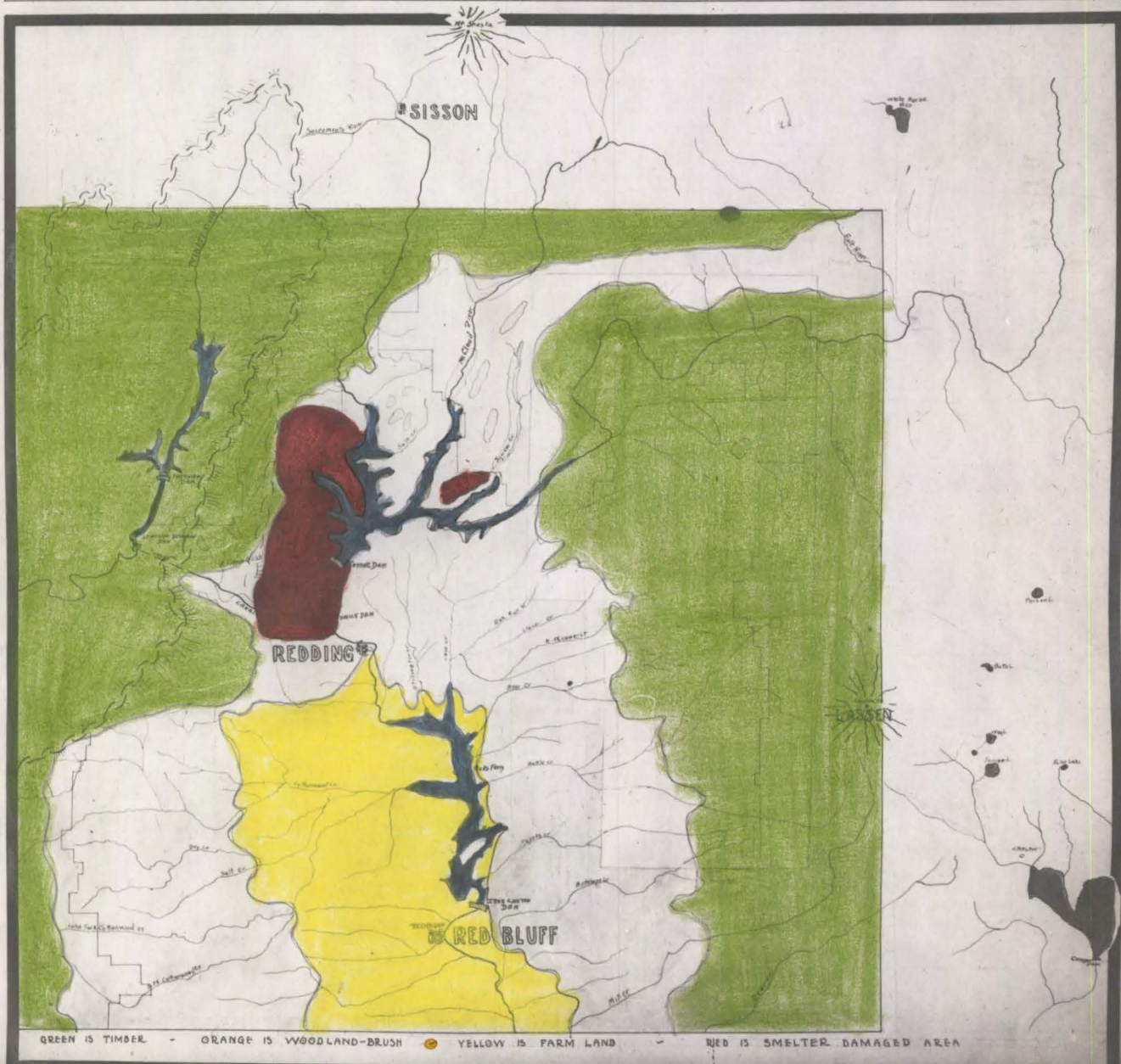
SHOWING RELATION OF

KENNETT AND BULLY HILL

SMELTER FUME DAMAGED AREAS

TO PROJECTED RESERVOIR SITES

SCALE APPROX. ¼"=MILE



our preliminary survey indicates a substantial decrease in capacity of this reservoir. (Illustrate.) About 15 per cent of this 133,000 acre watershed was burned over. The rough preliminary survey indicates a gross reduction in capacity of 55 per cent. If this were the end of the process of erosion it would cause no grave concern. But how long this process of erosion will continue, what its final volume will amount to, and the measures necessary for its control, are matters so far of pure conjecture and can be answered only by future investigation. The next illustration is the combined Iron Canyon and Kennet projects now under consideration by our Legislature. In reading the engineering reports there is no evidence that any weight is being given to the impending danger of heavy erosion from the 75,000 denuded acres in the smelter-fumed area at Kennett, or in the 10,000 acres denuded area of Bully Hill. (Show maps and photographs.) Not only are we confronted here with a soil movement on these waste-lands, but we have almost as serious a threat of additional erosion from the entire surrounding foothill country, subjected annually to the most severe types of summer fires. The public attitude of the native population within this region condones and encourages promiscuous burning. The practice of over-grazing, common to this region, will be another serious factor in increasing the danger of excessive erosion. The State expects to spend over 300 million dollars on these projects without any definite knowledge of the part played by the vegetative cover in the water cycle and how far present and future silting will affect the probable life of the investment. The necessity for hastening our forest influence studies and increasing their scope must surely be evident in the light of these striking examples of the need for scientific data. A number of southern engineers have evinced interest in the calling of a meeting of foresters and engineers for the purpose of considering this general problem and the studies that should be undertaken. The Council might care to consider the advisability of promoting such a conference and indicate to what extent they would advise the Station to contribute its efforts.

The Station is concerned with another series of studies; the management of our pine timberlands, aimed at determining the best silvicultural practices for our national forests so that maximum growth and the most desirable timber species may be assured. These studies, conducted on permanent sample plots, representing different growing conditions and types are beginning to yield definite and usable results. A series of progress reports have been made available to the Forest Service and other interested agencies and recently a publication entitled, "Tree Classification" by Dunning, has been issued. The findings of this publication have been recently incorporated by the Forest Service for use in its timber sale practice.

Our studies have indicated that complete fire protection, saving maximum advance reproduction, and maintaining the relative same mixture of species are essential to the perpetuation of our present forest productivity. While these studies have been largely confined to national forest lands, the basic data are in whole or in part applicable to the management of private timber properties where continuous forest production is wanted. Present unfavorable economic conditions

in the lumber industry have retarded any wide application of these desirable practices by the private timber holders in the pine region. The Station is recommending again a complete study which would evaluate and compare costs of desirable forest practice and of those systems now commonly used by the lumber industry in California. Such a study would correlate silviculture with logging costs and the ultimate net return from the lumber product.

To carry on this study would require the active cooperation of some going timber company. We feel certain that the results of such a study would clarify many misgivings of the lumber industry as to the probable costs of desirable forest practice and would stimulate consideration of the possibilities in a general acceptance of continuous cropping or sustained yield management. I hope that the members of the Council from the lumber industry will give this project serious consideration and support.

Fires continue to present serious problems in the management of the national forests, in the protection of valuable private timber lands, and in the protection of important watersheds. The total number of fires in the State for the year will probably exceed 2000. It is trite to say that without fire exclusion the management of lands for forestry purposes is impossible.

I want to briefly outline two fire projects that have been under way for a number of years. A series of detailed statistical analyses have been made, based on the complete records of individual fires handled by the national forest administration from 1911-1928. These analyses have been most helpful in the determination of fire hazards and risks, adequacy of fire fighting organizations and efficiency of methods of control. A study of the relationship of cover type to fire control has been recently completed and is ready for publication. An analysis of the fires during the critical years of 1924, 1926, and 1928 will be carried out in a similar manner. These statistical studies become more valuable as the data accumulate and as the records improve in quality.

During the past year the field study of light burning in a virgin pine forest area was completed on a 200-acre tract on the Plumas National Forest. This study, which was initiated in 1919, was designed to determine the protective value of annual light burning against summer fires and the costs and effects of such practice. In spite of the most diligent effort, only five burnings were accomplished in eight attempts and at no time was a complete light burn secured over the entire area under the experiment.

The difficulties encountered in attempting the initial burning, continued throughout each successive burn, including that of 1928. If the south side burned successfully the north slope could not be set afire even with the use of large blowtorches. When north slopes burned reasonably well, fires on the south slopes spread rapidly and most destructively.

The conclusions from this study emphasize the futility of controlled light burning in the pine belt. Young seedlings within the burned over area in each fire completely succumbed, regardless of the

intensity of the fire. Saplings and poles were seriously damaged and reduced in number. The burning down, by undercutting, of fire-scarred trees, continued in the same ratio as in the very first fire. Another constant and serious loss was the added concentration of insect attack and resultant damage when compared to the damage in adjacent unburned areas. Not only are there difficulties in carrying out the practice, but there is a steady reduction in the mature timber itself of about 900 board feet per acre per fire. These facts would indicate that further light-burning studies in the pine belt are probably unnecessary.

But after every bad fire year we may expect a public outburst in favor of light-burning, controlled burning and "Indian forestry". A good deal of this sentiment reflects an honest criticism of the inadequacy of present protection effort. One can sympathize with the timber owner who desires to safeguard his investment in merchantable timber and grasps at light burning as a panacea for all possible losses from lumber fires. More often than not, however, this sentiment for light burning is the outspoken selfish interest of non-property owners who have nothing at stake, whose desire is to burn brush and woodland, including timber, hoping that travel in the woods may be easier, game made more available, and forage increased. The light burning sentiment will probably only be curbed when protection against summer fires is air-tight and universal.

Mr. Show will later outline a new proposal for a comprehensive study of California's fire problem. It will be desirable for the Council to recommend specificallyhow far the Station should participate in this proposed study.

Continued progress has been made in the cover-type map as the first step in our economic studies. Since my last report we have completed 300 townships or nearly 7 million acres outside of the national forests. We are finding difficulties in completing the map in areas inadequately provided with base maps. The Council's help will be needed in bringing its influence to bear on the State and Federal agencies charged with map making in pushing forward work in the regions where only meagre and crude base maps exist at present. The cover-type map, even in its partial state of completion, has been already found of value. It has been used by Mr. Olmstead in his special report on State parks to be submitted to the State Park Board. We are now using this material in preparing a report for the State Forester showing the lands requiring protection against fires outside the national forests, and the data will be the basis for calculating California's share of Federal funds under the Clark-McNary act in cooperative fire protection. No sound study of land use can be made without data based on the cover type found in the State. Our next step will require a survey of the timber resources in California. We hope that the lumber industry and the Central Pacific R. R. Company who has been exceedingly generous in turning over their land data in the compilation of this map will also cooperate in the compilation of the timber resources data.

Both at the Devil Canyon and the Feather River Substations, experiments in raising forest planting stock and outplanting have been under way. In the main, artificial regeneration in our pine belt will

only be necessary where advance reproduction has been entirely destroyed, or where an attempt is being made to restore forests on brushfields or devastated areas. Planting will always be costly, and success will vary with our dry and wet cycles. Extensive reforestation andafforestation in southern California with coniferous trees can only be justified at present where the public desires future recreational forests of conifers and is willing to pay enormous costs for them. The Station's program should include some work in this field.

The Office of Products of the Station is working in two directions: First, the reduction of wood waste through the entire process of manufacture from the woods to the consumer; second, the increase of returns from lumber products, either through the elimination of waste and losses or through better use of lumber products.

Two projects of considerable importance are now being carried on: one dealing with the study of white fir, the other with blue stain in the pine. White fir presents a problem in silvicultural treatment because of lack of market for its lumber. This species is now being handled at a loss to the operator, and the problem is to find more satisfactory methods of manufacture and a profitable market. Ultimately this species may become a very important one in pulp production. Blue stain, a fungus disease causing degrade of high quality lumber reduces the value of the product by at least $500,000 a year in this State. The problem is to determine methods of positive control.

The staff in Products investigations carries on a good many other routine activities which are a drain in time but nevertheless essential. It is called upon to conduct the annual lumber census in cooperation with the Census Bureau. It has constant requests for identification of woods, recommendations for use and preservative treatment of lumber, and other sundry services for the wood using public. This is a form of extension service which no other public agency is handling. The chief of this Division has taken an active part in the Committee on Natural Resources of the California Economic Research Council. One could list a dozen important problems that should be under way in this field of research but which of necessity must await increased personnel and finances.

The Bureau of Entomology has assigned an entomologist to the Experiment Station to carry on special research in the field of entomology. The outstanding problem now under investigation deals with the life habits of western yellow pine bark beetle. The artificial control method now employed to curb the ravages of this insect have been costly and protracted, and a study of the biological factor offers great promise for ultimate control. A detailed description of this investigation will be presented later. The general tendency to spend millions for control of pests and pennies for fundamental research looking towards real prevention has been followed in the case of the bark beetle depredations. Only one man is giving full time to the fundamental work on this problem. The Council may well consider urging liberal increases to the Bureau of Entomology for this work.

The Biological Survey has assigned one worker to the Station to give part-time services on investigations of prime importance in our general program of work. Unfortunately, from the forester's standpoint the greater part of the time of this investigator must be given over to general rodent control. Excepting for a study of the porcupine as a factor in the destruction of forests no large project has yet been undertaken. Some preliminary investigations of the relationship of animals to forests will be carried out. Again, it is essential for the Council to consider the advisability of urging the full-time services of one man on biological investigations relating to forestry.

Ultimately, the provisions of the McSweeney-McNary act will unquestionably provide reasonable Federal allotments to carry on our comprehensive program of investigations. It would be well to point out, however, that the Forest Experiment Station should not be the only agency engaged in forest research. It is important for the Forestry School at the University of California to carry on independent research to stimulate original work by its teaching staff and graduate students. The happy relationship between the Station and the School is such that duplication of work is unnecessary and avoided and projects are as far as possible fully coordinated.

In conclusion I should like to specifically recommend for your discussion and consideration the following:

1. An increase in the scope of forest influence studies to the extent of using 50 per cent of any financial increases that may be forthcoming.

2. The Council to foster a meeting of foresters and engineers to consider the forest influence problem, and that a committee be appointed for that purpose.

3. That 50 per cent of any increases in this year's appropriation should be applied to fire studies.

4. That a committee be appointed to urge the proper agencies charged with map making to complete areas now lacking maps.

5. That the Council approve the combined silvicultural-logging-mill-scale study.

ABSTRACT OF REMARKS OF CHIEF FORESTER R. Y. STUART
AT MEETING OF THE ADVISORY COUNCIL
CALIFORNIA FOREST EXPERIMENT STATION

February 4, 1929

Major Stuart: "It is difficult to visualize a more urgent problem for the American people than that of digging into the questions involving the means of keeping our forest supplies adequate. The Forest Service is only 23 years old, having been given the job of administering the national forest properties in 1905. First attention was necessarily absorbed by the pressing problems of carrying on a going administration. On every hand was the need for more knowledge and it grew continuously more pressing. Such an enterprise must consider not only the direct problems of doing, but the effect of them upon community, state and national welfare. Administrative officers engrossed in daily duties have little time for finding new knowledge. Therein lies the value of organized research; but for that reason also research developed slowly. It is a little disappointing that the same importance has not been attached to the need for research in forestry as in industries and even in agriculture. What the Forest Service is able to do is a mere trifle in comparison with the need. The soundness of our administration is dependent upon the soundness of our knowledge and conclusions.

"Speaking before the Budget Bureau recently in behalf of a million dollar appropriation for fire preparedness, I said what has been said every time for years, that if we could only get more money for preparation, it would reduce tremendously the expenditures for fire control, besides leaving us the resources thus saved from burning. It is the same in research. Mr. Dunwoody here, and his Association, have performed a great service and contributed conspicuously to the passage of the McSweeney-McNary act. For increased appropriation for research at this Station he made a fine appeal at Washington against almost insuperable odds. It is a difficult fight but we are going to keep steadily on.

"Forest Service research is fortunate in having such a group as this of able men of large interests willing to consider with us the problems of what we should do. But the federal government is not the only agency; other problems should be taken up by the State. The action of the State of California in the consideration of the most effective means of expenditure of the $6,000,000 Park Board fund in which, as Mr. Kotok has pointed out, they have already used to great advantage the cover type map being made by this Station, is a splendid piece of work. There should be large areas held by the State, as well asby other minor public agencies, for determination of best use - for example, economic forest versus parks.

"Mr. Walker has touched upon an important question in the place of research in the Forest Service organization. This oganization is endeavoring to make its operations most efficient; but unless such an organization has fed into it a continuing stream of new ideas its efficiency will be shortlived. The function of research men is to be perpetually dissatisfied with things as they are and to keep administrative officers from becoming smugly satisfied with present performance.

"Mr. Show has proposed to establish on a single Forest what we cannot hope at present to do on all - to show in miniature what can be accomplished on a larger scale, by applying the best we know and by consistently increasing that knowledge. This is very necessary. We can't afford to be complacent with accomplishments now, and I doubt if it should ever be so. We thought we had taken a long step forward when Congress agreed to authorize increased appropriations and coordination of research activities. In respect to the control of bark-beetles, many Congressmen seemed to think that this should be Forest Service work. It is, inasmuch as it is necessary to the effective management and protection of forests; but we need the help of the technical men of the Entomology Bureau, and did all we could to help increase their resources.

"The Forest Service is deeply grateful to you men of this Advisory Council for your giving of your time and ability to the guidance and furtherance of this most important research work".

STATEMENT BY DISTRICT FORESTER S. B. SHOW
AT MEETING OF THE ADVISORY COUNCIL
CALIFORNIA FOREST EXPERIMENT STATION

February 4, 1929

District Forester Show outlined to the Council the need for an experimental fire forest in northern California on which could be applied all the protection measures now known and those to be later devised. He explained that the forest fire problem on many of the National Forests in California is not yet solved, and that more rapid progress both in administrative measures and in fire research was urgently required. Heretofore, the relatively small increases in appropriation available for fire protection have had to be spread over the entire state and this will continue to some degree. But he believed most rapid progress would result if all the various protection measures could be applied in one place because of the high degree to which they interlock and affect each other.

He stated that the bulk of the expense would be from administrative funds, but urged that study of methods, technique and results by the Experiment Station was an essential part of the project so that the results of different practices might be determined. In this part of the work, as well as in the planning of the entire project which will require the coming season he felt that the Experiment Station should take an active part.

After discussion, the Council expressed its position on his proposals in the following resolution:

> That this Council approves participation by the California Experiment Station in the preliminary planning of the work on an experimental fire forest and in carrying out whatever fire research may prove desirable on that forest. All this work is to be done in cooperation with the administrative organization of the Forest Service.
>
> The Council recognizes the urgent need for faster progress in solving the fire problem on the National Forests; believes in the method proposed as one essential measure and urges the administrative officers of the Forest Service to do everything possible in carrying out the undertaking without delay and on an adequate scale.

In his remarks to the Council, the Chief of the Forest Service, Major R. Y. Stuart, expressed approval of and interest in this project.

STUDIES IN FACTORS INFLUENCING THE SURFICIAL RUN-OFF OF RAIN AND EROSION

By W. C. Lowdermilk

February 4, 1929.

One of the most important basic physical problems confronting the nations bordering the Pacific Ocean is the conservation and management of the physical body of the soil mantle to maintain high standards of living in the younger nations indefinitely and to make possible the elevation of the living standards in the older nations.

The soil mantle is the product of weathering through geologic ages, but it may be cut up by gullies, washed away and otherwise damaged within decades on sloping lands as the result of activities resulting from human occupation of the land area. The soil mantle is not only the basis of crop and forest production, in short, of chlorophyll engineering; it serves, at the same time as retention storage of precipitation whence vegetation and streams are supplied with water.

Erosion of this soil mantle in excess of the geologic norm of erosion for given climatic and physiographic regions is a symptom of mismanagement of soil resources. Accelerated erosion is fatal to sustained production by the land surface. Accelerated erosion may at times be spectacular as is represented by gaping gullies, but however it proceeds, its continuance spells the reduction of the aggregate productivity of the land surface for its carrying capacity for the human race. The evidence derived from five expeditions into central and north China conducted by the writer is believed to indicate that erosion throughout two or more millenia has reduced the aggregate productivity of the landscape in the face of an increasing population.

Accelerated erosion is an index of the reduced absorption by the land area of falling rain. It represents a disturbance in the water and erosive regimes. Accelerated erosion represents the initiation of processes which usually increase in geometric ratio. Stages are soon reached in land with pronounced gradients where the eroding land will no longer justify the expenditure necessary for erosion control. The control of advanced erosion most generally costs more than the value of land fully reclaimed. Herein is the insidious waste, the progressive destructiveness of the process of erosion when unleashed beyond the norm which geologic environment of time, physiographic forms, geologic structure, and climate have established.

Our control of water on watersheds is therefore measured by our control of erosion.

The studies described below were begun in China six years ago. It was the writer's privilege to determine what measures forestry might furnish in a program of famine prevention for central and north China. After five years of diagnosis the conclusion was reached that erosion is the most damaging of the physical processes at work, and consequently erosion control was the most urgent measure to be employed.

In view of the inadequacy of former studies of the effect of vegetation on streamflow and vegetation, it was decided to make quantitative studies of the effect of vegetation on the surficial run-off and on erosion applicable to China.

The temple forests of China, fostered and protected about nearly every important Buddhist temple, furnished the basis of comparison of the possible changes in the regime of erosive processes. These temples are very numerous and are located in all the high lands of China. An attempt during the rainy season of 1924 to measure in the province of Shansi the torrential run-off from a small watershed failed because of the unwieldy nature of the sudden torrential flows of storm water heavily charged with silt, pebbles, and boulders of great size. The rise and fall of the current was too rapid to be satisfactorily recorded. Thereupon it was decided to discover how a land surface covered with vegetation influenced the distribution of falling rain as it fell upon the ground surface. In other words, the object was to determine what happened at the very beginning of the partition of waters into surficial run-off and into seepage. A run-off plot method was employed whereby plots with areas of 1000 square feet were so bordered that no outside run-off might invade nor any run-off leave the area except through the apertures which lead into specially designed tipping bucket instruments which measured and recorded the run-off. This method was employed in three remnant forest regions in the Province of Shansi during the rainy season of 1925.

The difference in surficial run-off was found to be manyfold, with an average of 57 fold, greater from the denuded plots than from the plots on otherwise similar soil which were mantled with vegetation. These results have been published.

It became apparent as was to be expected that the intensity of rain played an important part in the distribution of rain into sufficial run-off and seepage. Accordingly, a continuous clock-driven recording device was attached to a specially designed instrument to record the intensity of rainfall and the rate of run-off from the plots simultaneously. Tsingtao, Shantung, China, was the site of these studies in 1926 where it was possible to compare the effect of the forest reclamation work carried out by the German administration some 27 years previously on the surficial run-off from barren and unclaimed slopes denuded of vegetation by the Chinese fuel gatherers.

The results of this study proved to be significant and were reported before the Third Pan Pacific Science Congress in Tokyo, November 1926. Neither the intensity nor prolonged rains obliterated a pronounced difference in the relative absorption of the contrasted plots. A theoretical explanation of this phenomenon was offered in the Tokyo paper as follows:

"Absorption of down-pouring rain appears to be more dependent on the condition of the surface of the soil than on the average porosity of the soil layer. If a dashing rain will cause the fine particles of the soil to be washed into and fill up the surface pores of an otherwise porous soil, the absorptive capacity may be very distinctly reduced. This is the explanation arrived at by the writer in observing during rain storms the behavior of falling rain as it fell upon different types of surfaces.

In the year 1927 these studies were transferred from China to California at first in cooperation with the Division of Forestry, University of California and now they form a part of the program of the California Forest Experiment Station.

In order to answer the question arising out of the Tsingtao experiments it was decided to determine the relative influence of the natural forest litter on the distribution of the rain into surficial run-off and seepage. Accordingly an experiment was set up on the Oxford Street tract in Berkeley by the kind permission of President Campbell, in which eight large tanks were installed and filled with soils derived from three representative regions. The tanks are 2 feetwide, 5 feet long, and hold a 2.5 foot profile of soil. They are set at a slope of 30 per cent, and are provided with baffles to lead the surficial run-off first through a silt trap, then into the run-off measuring tank. The seepage through the soil profile is measured into a second set of seepage tanks. (Slides.) Artificial rain was applied, totalling approximately 160 inches in 74 separate runs, besides the natural fall of rain. The runs were divided into series of ten of equal duration. The following durations were used:

Preliminaries	10 runs
1/2 hour	10 "
1 "	10 "
2 Hours	14 "
4 "	10 "
8 "	10 "
4-15 minute intervals	10 "
Total -	74 "

Tanks I and II were filled with a soil sample of the Aiken series in natural order which was collected near Placerville under a pine - fir - cedar forest. Tanks III and IV were filled with a sample of the Holland Sierra series of the Stanislaus National Forest under a pine - fir forest type. Tanks V, VI, VII, and VIII were filled with a sample of the Altamont series from the Berkeley Hills, under a cover of chaparral forest. The natural forest litter was applied to the tank soil surfaces. Thereupon the litter layer in the odd numbered tanks was burned off with a hand torch. The variable isolated was as nearly as could be determined the presence of forest litter and its absence by reason of fire. The results were decisive in indicating that the litter

layer rendered the soil profile much more absorptive of the rain than the bare area. Results of Series V, representing the 10 runs of 8-hour applications of approximately 8 inches of rain each run, are shown in the accompanying chart.

It is apparent that the litter layer is effective in rendering a sloping soil surface more absorptive even under very heavy applications of rain. The finer textured the soil the more effective does the litter become as is evidenced by the results from the Tanks V, VI, VII, and VIII, filled with the Berkeley Hills soil.

Erosion is affected in an even greater degree by the forest litter as is shown comparatively by the chart. Whereas the run-off from the burned surfaces was from 3 to 20 times that from the litter covered surfaces, the eroded material varied from 1000 to 5000 fold as much.

The explanation of this marked difference in the percolation capacityof the soils treated thus was suspected to be related to the differences in clarity of the rain water. As the rain water fell upon the bare surface, soil particles were taken into suspension and were filtered out as the water sank into the soil. It was suspected that the seepage pores and channels were partially sealed, which accounted for the marked difference in the surficial run-off, whereas the litter covered soils retained the rain water clear, and the seepage pores and channels were not sealed. Hence the full percolation capacity of the profile was permitted to function in absorbing the rain as it fell. This effect persisted regardless of the amount of rain applied to the tanks up to the heavy application of 8 to 10 inches in 8 hours for 10 consecutive runs spaced two days apart. Fully 80 inches of rain was applied in 21 days.

In order to test the plausibility of the sealing effect of suspended material in percolating muddy water, an experiment was designed and set up in the laboratory. Four tubes of A soil were set up, through which clear water was percolated for 10 days to determine the characteristics of each tube. Thereupon muddy water constantly agitated was applied to two of the tubes. The sudden drop in the clear water rate of percolation is shown in Chart No. 2. In six hours the percolation rate had dropped off to one-tenth of the clear water rate. After another ten days of application muddy water was applied to the other two tubes through which clear water had been percolating from the initiation of the run. Thereupon the rate of percolation of the muddy water fell off in a similar manner as it had previously

This result seems to establish conclusively that the forest litter functions chiefly in its capacity, not to absorb water, but to keep the falling rain waters clear and to make possible the absorption of falling rain to the full percolation capacity of the soil profile. The condition at the surface, therefore, is critical. It is the forest litter rather than the kind of vegetation, whether high forest or low shrub, that is important in determining the distribution of the falling rain into surficial run-off determinative of surface soil erosion and into seepage.

This marks the culmination of the investigation of a particular factor affecting the absorption of rain which was begun in China in 1923.

There remains among other problems in the effect of vegetation on water conservation, the next most urgent: the determination of the amount of water which vegetation transpires and removes from the ground water supplies. With this is also intimately related the loss of water from the soil by direct evaporation. This problem is to be attacked in a definite way in the near future.

WATER CYCLE STUDIES

S-V RUN-OFF, SEEPAGE AND EROSION P= 78.50± IN.

100 PER CENT BLUE = SEEPAGE RED = RUN-OFF HACHURE = SILT

BURNED | UNBURNED | BURNED | UNBURNED | BURNED | UNBURNED | BURNED | UNBURNED

RUN-OFF AND SEEPAGE IN PERCENT OF RAINFALL

ACRE FEET PER TONS IN SILT

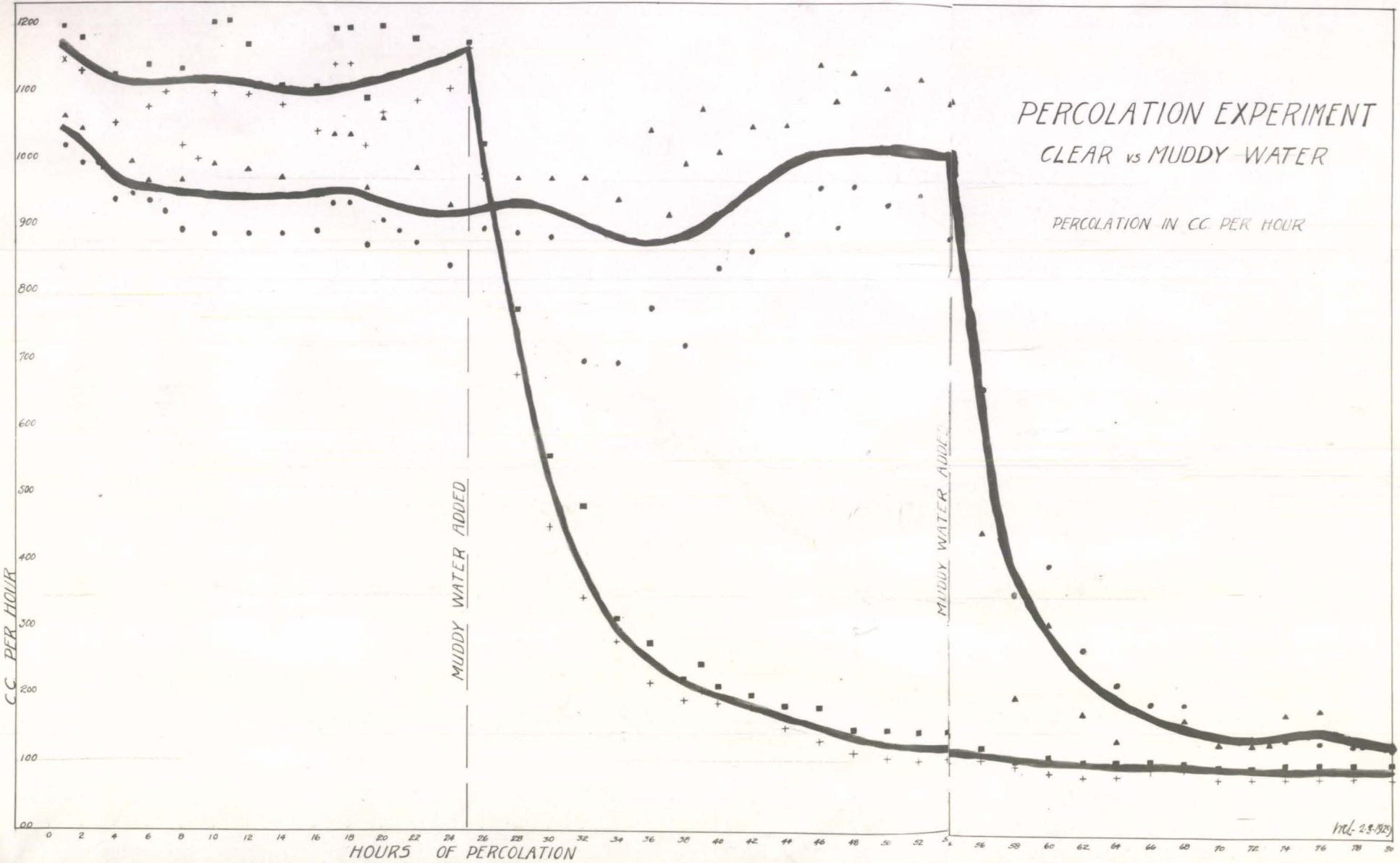
36.61 | 62.24 | 4.39 | 89.23 | 23.27 | 69.54 | 10.22 | 91.72 | 37.76 | 43.02 | 3.62 | 94.52 | 51.44 | 49.72 | 4.16 | 101.39

10.82 | 21.75

TANKS I II III IV V VI VII VIII

PLACERVILLE SAMPLE | STANISLAUS N.F. SAMPLE | BERKELEY HILLS DUPLICATE SAMPLES

2-7-19 MK


PERCOLATION EXPERIMENT
CLEAR vs MUDDY WATER
PERCOLATION IN CC. PER HOUR
C.C. PER HOUR
MUDDY WATER ADDED
MUDDY WATER ADDED
HOURS OF PERCOLATION
1200
1100
1000
900
800
700
600
500
400
300
200
100
00
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80

OUTLINE OF WORK OF THE EXPERIMENT STATION IN SOUTHERN CALIFORNIA

By C. J. Kraebel

February 4, 1929

The Station activities in the south, in addition to the intensive superficial erosion studies described by Mr. Lowdermilk, deal with four projects:

Erosion study of Barranca Watershed
Forestation
Climatological observations
Collection of water use data

Barranca watershed study

The Barranca Burn is a typical small canyon in the suth face of the San Bernardino Mountains where the characteristic cover is dwarf forest of mixed shrubs commonly called "chaparral". The canyon covers 44 acres extending in elevation from 1950 feet to 3100 feet, is long and narrow with very steep slopes in its lower two-thirds and gentle rolling topography in its upper third. In September 1925 a severe fire burned over the entire area completely denuding it of vegetation. The first rains of the following winter resulted in torrential run-off and erosion from the area and in the gouging out of a deep gully through the ancient outwash fan at the canyon mouth. In 1927 the Experiment Station began work on the area chiefly for the purpose of developing methods for a comprehensive study of forest influence on run-off and erosion under southern California conditions.

Somewhat similar studies of that much mooted question have been conducted in other parts of the world; first, in Switzerland, by Professor Engler, comparing the rainfall - run-off ratios and the erosion of two watersheds having contrasting densities of forest cover; second, at Wagon Wheel Gap, Colorado, cooperatively by the Forest Service and Weather Bureau, in which a similar comparison of watersheds was made but with the added feature of deliberately cutting the tree-growth from one of the watersheds; third, at Ephraim, Utah, by the Forest Service, a study now in progress of the run-off and erosional effects of grazing. Closely related studies of run-off and erosion from agricultural lands have also been made by the U. S. Department of Agriculture.

While all of these studies involve some principlesof general application, none of their results can be applied specifically and quantitatively to the situation in southern California. There the semi-arid climate, the limited but frequently torrential rainfall, and the dwaff-forest or chaparral cover of the mountains, constitute a set of conditions different from those heretofore studied. These differences

alone might not justify local study, but, by reason of the intensive agricultural development and the rapid growth of population, there is real danger of water shortage and hence a pressing need to learn just how the chaparral cover functions in the water and soil economy of the region. To express the question more specifically: what are the water-regulating and soil-conserving values of the chaparral?

The problem is extremely complex and calls for quantitative data not hitherto available. By intensive methods Mr. Lowdermilk's projects attack the problem at the critical point: where the raindrop hits the ground. There remains the necessity of correlating the findings of such intensive studies with the processes and events which occur on watersheds as a whole. It is believed that this must ultimately be done by a comprehensive study of two similar watersheds, one to be denuded, the other to be left with its forest cover intact. The Barranca Watershed Study is at present concerned primarily with the development of a technique suited to such a study in southern California, and secondarily with the measurement of the processes of erosion and vegetative recovery on a typical watershed some years after its denudation by fire. Some specific objectives may be discussed:

1. To evolve satisfactory methods of measuring run-off and erosion on a large scale, as from a watershed of 20 acres or larger. The measurement of normal well-regulated flows is comparatively simple, but no method has yet been proven for accurately measuring flood flows laden with excessive burdens of silt, gravel and boulders.

Sediments are now measured with sufficient accuracy by means of a settling basin in the form of an earth-dam reservoir ~~reservoir~~ at the canyon mouth which is carefully surveyed after each large deposit. Water escapes by seepage and evaporation; later, if the basin floor is made impermeable by silt, a siphon may be used. Should the basin overflow, provision is made to measure the overflow through a weir in the concrete wasteway.

Water-flow measurement, attempted last year by means of a standard rectangular weir, proved unsatisfactory because erosion-debris unexpectedly filled the weir-basin more rapidly than it could be removed, thus invalidating the flow formula. There is now installed a rated Parshall flume which permits the passage of sand, gravel, and boulders up to 12 inches in diameter. This instrument has satisfactorily recorded one flow during the present winter and holds high promise of success.

2. To measure the rates of run-off and erosion from the Barranca Burn in terms of flow and deposition at the canyon mouth, beginning two years after burning and continuing for a number of years to observe changes.

It seems reasonable to suppose that the rates of run-off and erosion should show diminishing curves with the passage of time, both because the principal movement of loose surface soil occurred shortly after the fire, and because the recovering vegetation offers increasing resistance to water and soil movement. The situation, however, is not so simple.

Numerous other factors must be taken into account, such as the kind of soil and degree of its slope, kind and age of the vegetation before burning, the vegetational changes following burning, and, particularly, the distribution and intensity of rainfall during the several years immediately following the fire.

The single factor, intensity of rainfall, is capable alone of over-riding all other factors and causing flood run-off and great erosion quite out of line with the normal expectations for any particular area on the basis of its vegetational condition and the time-lapse since the fire.

The Barranca study, therefore, aims to correlate measurements at the canyon mouth with the various influencing factors.

3. To observe in detail the vegetative succession following fire in chaparral. Thirty-eight small permanent plots distributed over the area are examined annually, their vegetation charted, described, and photographed. A climatological station in the center of the area equipped with recording instruments secures the site-factor data needed to analyze the vegetative movement. Both these observations must be carried on for a number of years until the cover again approaches a condition of relative stability.

Forestation studies.

In the light of present knowledge the place and possibilities of forestation in the chaparral region are still undetermined, and since the primary objective is to secure the optimum watershed cover there is involved experimentation not only with trees but with shrubs, herbs, and grasses as well. Specific objectives are:

1. Recovery of barren areas in order to check destructive soil erosion.

2. Determination of possibilities of altering the present cover to a composition which will be less inflammable, require less water for its own growth, offer better protection of the soil against erosion, and which finally, will keep the soil surface more receptive to the entrance of water than the present chaparral.

3. Extension of present coniferous areas and the planting of conifers in selected areas for their own sake. This feature is followed in response to a large public demand in the south for pine forest planting and is necessarily limited to canyon bottoms, bench lands, recreation areas where some promise of success is offered by the quality of the sites and the care which may be given the trees after planting.

4. Introduction of exotic species both foreign and domestic, with special emphasis on succulents.

Our attack on the forestation problem falls into three distinct phases; first, a survey of past efforts and the determination of the reasons for their success or failure; second, nursery practice or propagation technique; third, methods of out-planting and direct-seeding in the field.

Throughout the south there are scattering examples of successful mountain planting of conifers, more of eucalypts, less of other hardwoods, and very few of shrubs and lesser plants. Such plantations are valuable indicators for the localities where they occur. In some of the recent projects of the Los Angeles County Forestry Department, for example, there are indications that direct seeding may be used successfully with Coulter pine in favorable localities. The percentage of survival of "direct" seedlings appears to be as high as of planted stock and their rate of growth is actually better.

For many species, however, we shall still have to rely upon plants raised in a nursery, and this entails careful study of nursery methods to produce the best type of plants of all such species. This is especially true of native shrubs, of the hardy but non-commercial conifers and of practically all species introduced from abroad for which we have no experience to draw upon.

Similarly, the methods of planting and direct-sowing in the field are being studied to discover by what means the highest measure of success can be obtained. The first objective is to get planted trees to live and thereafter the operation may be speeded up to reduce costs. If, for example, direct-seeding is proven satisfactory by controlled experiments, this method should greatly reduce forestation costs, since seedspots can be put in at the rate of 500 to 1000 per man per day as against the planting of 40 to 100 trees per man per day.

The testing of exotic species is continued in the effort to discover trees or other plants which are more desirable than the native chaparral in enough different ways to justify their introduction on a large scale. For example, if a highly succulent tree, shrub or vine can be made to grow densely on our suthern firebreaks this may save the heavy annual expenditures for maintenance and will keep the breaks in far more effective condition - may thus be the means of preventing fires on untold thousands of acres. If successful in the breaks such plants may be gradually dispersed over the mountain slopes to mix with the native chaparral or ultimately, in certain localities, to displace it altogether.

In this work, however, caution must be the watchword. It is quite possible that an introduced tree or plant may not only succeed in its new environment but may find conditions so favorable that it may spread widely and rapidly, choking out the native vegetation and completely occupying the land. In many parts of the world today there exist examples of vast areas of land completely possessed by plants, some obnoxious, some useful, which were originally introduced for ornament or accidentally and which escaped cultivation.

In Hawaii, for example, Hilo grass, imported from Central America, is seriously encroaching upon the native rain forest, and the common Lantana has escaped cultivation as an ornamental and now covers thousands of acres on dry slopes to the exclusion of all native vegetation. A "good" example is the lowly mesquite of our Southwest deserts, which, in Hawaiian valleys and coastal plains, has developed into a fine thrifty tree, favored in towns as a shade tree, and elsewhere relied upon for important supplies of firewood, cattle feed, and bee pasture.

It thus clearly behooves us to study closely the qualities of all species considered for planting. Indeed it is conceivable that certain species now growing in the chaparral forest may prove to be the most desirable from all standpoints - in which case our effort should be directed towards increasing their proportion in the cover.

Climatological observations.

The purpose of this project is to establish meteorological instrument stations at strategic places throughout the southern mountains to augment existing stations in securing those continuous climatological records which are essential in any thoroughgoing forest study. Data secured by these stations include continuous records of air temperature, relative humidity and rainfall, weekly records of total wind movement, and check records of unusual wind velocities. The following stations are now being maintained.

1. Devil Canyon Nursery; elevation 2700 feet; San Bernardino Mountains; established 1927.

2. Knapp Lodge; elevation 3000 feet; Santa Ynez Mountains above Santa Barbara; established 1928.

3. Santa Ynez Ranger Station; elevation 1000 feet; Santa Ynez Valley, Santa Barbara National Forest; established 1928.

Water Use.

A survey of the data on water supplies and water consumption being collected in southern California by various agencies, such as the U. S. Geological Survey, Weather Bureau, and Forest Service, State, County, and Municipal Engineers, irrigation and power companies, flood control organizations, large private irrigationists, etc. Such a survey will make possible an analysis of the water situation with respect to the relationship of total use to total supply and replenishment. It will also discover omissions in the record and point the way to improvement by coordination of effort. Much information vitally needed for a satisfactory understanding of the water situation and for the formulation of any broad plan of conservation is now lacking, not only on water consumption from many municipal and large private sources but also on precipitation, the latter especially in mountain watersheds.

On this project the accumulation of published data has been begun, and no work other than to continue such accumulation can be undertaken until the whole time of one man can be devoted to it.

MANAGEMENT STUDIES

By Duncan Dunning

February 4, 1929.

It is perhaps worth while to review briefly the scope and objectives of management studies before taking up accomplishments and future plans.

Scope

Under the heading Management Studies are grouped a series of projects designed to determine the biological and economic factors fundamental to the continued growth and harvesting of timber on public and private land. These studies have been confined, thus far, to the pine - fir forests of the Sierra and coast ranges, to the accessible portions of this region where cutting hasbeen feasible, or soon will be, and to the five species of present economic importance, sugar pine, western yellow pine, Douglas fir, white fir, and incense cedar.

Objectives

Selection stands that are now merchantable. The composition is complex - but two of the species can now be cut with much profit. The stands are understocked. The distribution on the ground is irregular, the age-class distribution is poor, the preponderance of volume being in mature and over-mature trees. Uncontrolled decay is taking a toll of this more valuable wood. Tree killing insects cause serious losses. A host of worthless shrubs occupy much of the soil.

Specifically the things we are trying to determine first are:

1. The relative rates of growth of the important species.

2. How these rates are affected by differences in soil quality - or site.

3. How these rates are affected by removal of varying portions of the stand by different methods of cutting.

4. Within a species, what types of trees, as to age, size and dominance, are the best producers of wood.

5. Losses. Obviously the amount of wood remaining to be harvested is dependent on survival as well as growth rates. We must determine the extent of losses, causes and methods of control. Here methods of felling, yarding and slash disposal are considered as well as insects, diseases, wind, snow, etc.

6. To determine the relative returns from different methods of cutting in stands of varying composition, condition, and accessibility as determined by average value of product and average cost of production, considering growth, losses and waste.

7. How to control the host of shrubby and weed species that retard growth and hamper reproduction. What changes take place in the subordinate vegetation after cutting. These things have a bearing, not only upon timber production, but upon grazing and wild life resources.

8. How cutting and slash disposal affect the soil. Will productivity continue?

9. The factors controlling successful natural regeneration, seed production, germination, survival, growth.

In even-aged second growth stands not yet merchantable.

The problems here are of secondary importance, but a beginning must be made now. They concern principally the determination of the silviculture and economics of thinning and yield capacities.

The study of tree roots has a bearing on all of the problems mentioned above as well as upon fire control and watershed protection. At present our treatment of the forest is based entirely upon the behavior of the above ground portions of the trees.

Mensuration problems likewise are involved in all of the studies heretofore mentioned and are important to all wood using industries. Log rules, volume tables, instruments, field and statistical methods are necessary tolls which must be developed.

Accomplishments.

As regards selection stands, we have made material progress towards the first five objectives listed - that is growth as related to species, tree classes, site quality, methods of cutting and losses.

Beginning in 1910 there have been established 29 so-called methods of cutting sample plots on timber sale areas. These vary in size from 6 to 160 acres, aggregating 481.5 acres. They have 22,871 numbered trees, of which we have individual records at five-year intervals. In addition we have made examinations of many private cut-over acres and I have a large volume of data from current inventories of all sale areas. The administrative men have contributed valuable studies of logging damage.

The information thus secured has made possible several revisions in marking practice.

We have ceased to discriminate against the so-called inferior species on the basis of growth relations.

We no longer attempt to change the composition of standsin one cutting by trying to secure new reproduction - but bend our efforts toward the preservation of advance growth.

The volume of the reserve is better correlated with site quality than formerly. We have a working basis for site determination.

Average stand growth rates have been improved through reservation of better types of trees and better distribution.

Losses are being reduced through improved regulation of felling and yarding and through the introduction of less destructive methods of yarding. We have a better conception of types of trees susceptible to insect attacks and are eliminating these from the stands.

Slash disposal methods have been greatly improved.

We have developed criteria for the prediction of yields in management plans.

We have an improved basis for evaluating the work of timber sale administration.

Elementary silvicultural and protection measures have been formulated for the keeping of private forest land productive.

In the study of natural reproduction we have made only a beginning. The factors involved are very complex and we have not had equipment and men for carefully controlled studies.

Annual records of seed bearing are being accumulated for many numbered trees under various conditions of stand and site.

Progress of restocking and the survival and growth of advance reproduction are being followed on 1230 quadrats, 220 chains of transects, and 12 larger plots. Temporary strips have been examined on many private cut-over areas.

The factors of seed supply and conditions for germination are being followed on 114 screened and unscreened control plots.

The influence of competing vegetation and changes in such vegetation is being determined on many of the areas mentioned above.

As to soil studies we have done practically nothing.

On the economics of cutting in stands of varying condition little has been accomplished.

In <u>even-aged second growth stands</u> - we have 22 sample plots representing 8 methods of thinning, 4 types and 3 site classes.

Yield tables have been prepared for western yellow pine. Tables for white fir and red fir have been completed by the University of California. A Douglas fir table is in preparation.

Records are available for 347 temporary plots in mixed stands - not enough for yield tables.

Mensuration

We have fairly satisfactory volume tables for most of the species, both second growth and older trees, but not for all site classes.

Root studies have been under way only a short time. The literature has been reviewed, the study of spacing in even-aged fully stocked stands begun, and a beginning made in the study of the influence of competing seed trees and subordinate vegetation on tree seedlings. In addition, an effort has been made to release suppressed seedlings by severing competing roots without changing the light relation. A method of root excavation has been tried out which overcomes much of the difficulties that have prevented progress in the past.

Plans for the immediate future.

Methods of cutting in selection stands. Further plots are to be established to complete the series of type, site and cutting variables. First attention will be given to the Butterfly area, Plumas, in which variations in cutting will be the principal consideration, and the Modoc lava beds area for variations of cutting and for control of insects in pure pine or poor site quality.

A number of control areas in undisturbed forest are badly needed. It has heretofore been impossible to reserve such areas without serious interference with logging. Such areas are planned for the Stanislaus, Plumas and Modoc forests.

The most urgent project, and the one of most concern to the lumber industry and the Forest Service, is a thorough analysis of the economics of cutting and production. If information were available as to the character of stands and the character of trees that can be cut at a profit, it seems likely that both government and private cutting would be radically changed. It has been impossible to evaluate the success of our silviculture in terms of money because we could not follow the trees through to the final product. Cooperation from some mill owner is necessary. If such cooperation can be secured, the study will be carried out this year.

We hope to crowd forward more rapidly the study of natural reproduction. It is hoped that our biologist, Mr. Horn, may have greater freedom of time to devote to a thorough study of the relation of animals to seed supply and seeding damage.

We hope to continue on a larger scale the study of roots particularly with relation to reproduction and competition.

Very little new work is planned on yields or thinnings in second growth stands or in purely mensurational lines. The most urgent thing here is to improve and complete the basis for growth predictions in selection stands.

STATEMENT ON PROPOSED WOODS AND MILL STUDIES
FOR THE ADVISORY COUNCIL MEETING

By C. L. Hill
In Charge, Forest Products Investigations

February 4, 1929.

In the growth of American forestry the time has arrived when the most pressing problem is the securing of actual forestry practice in the woods, not only on the national forests, but on the privately owned forest lands which constitute 75 per cent of the total forest producing lands of the nation. On these private lands not even a respectable start has yet been accomplished toward the insuring of a new forest crop to replace that which is being removed, or towards the control of cutting at the amount the lands will grow, which we call sustained yield and which is the absolute prerequisite of national safety in respect to future timber supplies. Foresters do not feel, in fact, that private ownership is doing at all what it has reasonably been demonstrated can be done, with financial safety, and in some cases even with profit to itself. But, however that may be, it must be recognized that the lumberman like any prudent business man, must have intelligent, detailed data in respect to measures necessary, their costs and the returns to be expected, taking into consideration the feasibility and cost of changes in business organization and basis made necessary by the practices to be adopted. All but possibly the latter of these it is incumbent upon foresters to supply. No company can be expected to plunge into such a venture on any other basis.

In the past foresters have been unable to supply such specific data, chiefly because of lack of sufficient basic knowledge covering widely enough distributed areas and conditions, or, where data were directly applicable, because of lack for that place of other data needed. In the Forest Service, silvicultural studies have covered rate of growth in stands of various ages and of reproduction, in virgin stands and after various kinds of cutting, of damage to reproduction by logging, and many other factors. Logging engineers have studied costs of logging, brush disposal, etc. Products has conducted mill scale studies, i. e., studies of mill realization in lumber from given logs, studies of the losses in air and kiln seasoning, and of remanufacture of various kinds, etc. But these sundry phases have never been usable as the timber owner and operator must now use them, because never tied together on logs from the same timber stand with portions treated in different definite ways, and carried, on those same logs, through logging and milling clear to the shipping deck. Thus, not only is the lumberman unable to tell what he can solvently do of the things which he is besought to do nor can the public tell what it is reasonable to ask the lumberman to do, either in measures for forest perpetuation or in the avoidance of the waste now incurred in woods and mill or in the salvaging of that waste.

This, then, is precisely what the Station proposes in the study which we call the woods and mill study. Two adjacent and similar areas, of say 20 acres each, will be logged, one as the company usually does, the other as it should be logged, to best secure a future stand and a good second cut at the end of thirty or forty years. The costs of logging will be carefully obtained on each, the damage to reproduction and the remaining stand, the amount, kind, and value of waste left on the area, the cost of getting logs to the mill and, at the mill the cost of conversion and the waste and losses incurred, both in manufacture and in seasoning, as well as the amount, grades and value of the product realized at the shipping deck.

This is a project of no small magnitude and complexity, and will require the united resources of the Silvicultural and Products branches of the Experiment Station, the Office of Forest Management at the San Francisco Forest Service office, the logging engineering branch of the University Forestry School, the federal Forest Pathologist at San Francisco, and the cooperating lumber company.

But it will show, not only the primary data which have been mentioned, It should show, as to the individual tree, which are the most profitable, where profit ceases (both in diameter and defect), the effect of the kinds of logging used on reproduction already in place and on seed trees and future reproduction and on the reserve stands, when the areas can be logged again and what they will yield; in short a large part of the critical information necessary for the appraisal of the chance of profitable forestry practice. All this is, of course, only for the forest, conditions and methods actually used in the experiment itself. It will have to be repeated, no doubt, for other forest conditions and methods, to build up the total volume of knowledge needed. But in its results, nevertheless, we believe there are few things, if anything, that the Station could do which will be of greater value than this to the lumber industry itself, or to the ultimate public objective of getting forestry into actual practice in the woods.

STAIN PREVENTION PROJECT STATEMENT FOR
ADVISORY COUNCIL, CALIFORNIA FOREST EXPERIMENT STATION

By C. L. Hill

In Charge, Forest Products Investigations

February 4, 1929.

Stains affecting lumber are:

1. Organic stains, caused by fungus organisms, chiefly allied to the common molds, not producing decay but depreciating the value of lumber for many purposes, by destroying its clean, bright appearance, especially that of its sapwood. Chief one in prevalence and damage is blue stain; also an orange stain and others less important.

2. Chemical stains, also chiefly affecting the pines. Held in solution in sap of green wood and deposited on or beneath surface by evaporation of the water. Most serious is brown stain, appearing only in kiln drying in case of western yellow (trade name California white) pine, but in sugar pine also affecting air dried stock.

Effect on value of lumber. Most consumers think blue stain is a form of decay and are afraid to use it. While it is not in itself a decay, the conditions which favor its development also favor that of the decay fungi, so that some care is demanded in the use of stained lumber to insure that decay is not also present. But the stain alone seriously reduces the usability and the market value of lumber. Shop lumber requirements are so exacting that not a trace of stain is allowed. Stained lumber is not usable for natural finish; although finish, as well as even doors and sash which are to be painted could well admit it to a much larger extent than they do. Here is an opening for educational work against the consumers' unreasoning total prejudice. Box lumber cannot admit stain.

In short stain, by degrading of the lumber, is estimated to cost the lumber industry a half million dollars a year in California alone. In addition to which it contributes to the prejudice against lumber in general and to the inroads of substituted materials, which are now so seriously affecting the whole lumber industry. Indeed, it constitutes in the total a very serious factor in the whole unhealthy and unsatisfactory condition of the lumber industry.

But the effect of stain does not stop with the profits of the lumber industry, as such. The reduced total value of the lumber produced decreases stumpage values. Thus it affects also the Government, as a stumpage owner, equally with the private owner of timber. And, both by holding stumpage values below the point which will repay the growing of new forests, and through the straightened financial condition of the lumber industry, which prevents it from undertaking any increased expenditures, stain is a considerable factor in delaying the real practice

of sustained yield forestry on private, as well as public, timber lands, which is the major objective of all foresters.

How staining can be reduced. Blue stain, like any other organic growth, must have certain optimum conditions of moisture content and heat and food. High temperatures, such as in kiln drying the wood, will kill the stain producing organism. After kiln drying, if the lumber is given reasonable protection against reabsorption of moisture, it is too dry for the stain to develop. But kiln drying is a pretty expensive remedy for the less valuable grades. Stain may also be prevented by treating the freshly sawed lumber with some solution which is poisonous to the stain fungi. Such a poison must be applied immediately, as the stain under favorable conditions of humidity and temperature, can develop within 24 hours from the saw. It must not itself stain the lumber. Its effectiveness must last during the period of seasoning of the lumber, or say for six months. And it must be cheap in itself and capable of being cheaply applied.

The most usual means of application are by dipping the boards, mechanically, or by spraying, as they pass from the saw to the sorting table. The chemicals most commonly used in the past, and still largely used in the East, are soda, either the carbonate or bicarbonate or both. In California, however, the staining conditions, largely due to our tule fogs, are so severe, when they do hit, that the traditional materials are of little value.

Station experiment. The urgency of this situation has therefore led the Station to a project involving the trial, in cooperation with one of our largest pine region sawmills, of a number of new preventive chemicals. One is a German compound, one Swedish, and two are newly compounded by one of our largest American chemical houses. These are in addition to two simple chemicals, namely, borax and mercuric chlorid. Sugar pine is being chiefly used because it is the most valuable pine species, has considerable demand for air dried material, and is affected by stain in heartwood as well as in sapwood.

The project has involved an enormous amount of work, including the dipping of some 200 M feet of lumber treated with different chemicals, concentrations, and immersion times; careful piling of that and an equal amount of untreated control stock; repeated inspections to determine the progress of stain formation; final taking down of piles with record of every detail of each side of every board; and the computation and analysis of over a million items of data. Preliminary results, however, show much promise of success, and if this is achieved the benefits will many times outweigh every year the total cost of the research.

FOREST INSECT INVESTIGATIONS

Hubert L. Person

Address before the Advisory Council of the California Forest Experiment Station in San Francisco on February 4, 1929.

Although there are a number of major problems in forest entomology on which research is badly needed, the seriousness of the losses caused by the western pine beetle has resulted in the concentration of our work on this problem at the expense of the others. It is not the only forest insect problem in California but it is undoubtedly the most important one.

The western pine beetle is always at work throughout the entire Pacific Coast Range of the western yellow pine, but because it normally attacks trees only here and there throughout the stands, not in large, conspicuous groups, the loss often goes unnoticed. The so-called normal, endemic loss goes on year after year, taking from 0.1 to one per cent of the western yellow pine stands annually. Even though the loss remained at this relatively low figure the problem would be serious enough to require attention. But, unfortunately, as a result of certain combinations of conditions in which drought plays a very important part, our western yellow pine stands are subject to insect epidemics which result in an annual loss of between two and three per cent of the entire stand over large areas. In smaller divisions of these areas, such as a township or more, losses as high as 14 per cent of the stand in one year have occurred within the last few years. On the million and a quarter acres included in the southern Oregon - northern California project the loss in 1926 amounted to approximately 280 million board feet, or 2.18 per cent of the stand. At present stumpage prices the monetary loss was nearly a million and a quarter dollars for the year in this one area. On the Happy Camp - Lava Beds area of the Modoc National Forest, which includes 577,000 acres, the loss in 1927 amounted to 184,000,000 feet B. M., or more than three per cent of the stand. Sample plots within this area showed losses of approximately 25 per cent of the stand within the last five years.

Most of us realize the importance of the fire problem, and it is unquestionably our most serious forestry problem, taking the state or the nation as a whole; but in the pure western yellow pine stands of northern California and southern Oregon the insect loss for a ten year period (1910 to 1920) was found to be ten times as great as the loss from fire.

In our work with the western pine beetle we have recognized two fairly distinct problems, (1) the protection of virgin stands which are often overmature and decadent, in which the control of outbreaks after they have occurred is the chief problem, and (2) the protection of a second growth stands and trees left for increment and reseeding on cutover areas in connection with which the prevention of losses through silvicultural methods

is possible. We must take our virgin stands as they are and try to keep the losses at a low point by the use of artificial control, judiciously used, and by the protection and encouragement of the natural enemies of the bark beetles. But the stands of the future which are now being reserved on some of our cutover areas are the result of our own silvicultural practices; and with a better understanding of the habits and preferences of the tree killing insects and their associates we should be able to develop stands in which the loss from insects will be much lower than it now is.

The control of insect outbreaks in our virgin stands, until recently, has depended entirely on artificial methods of felling and burning the infested trees. Although there is still opportunity for improvement in these methods we are probably nearing the limit of what can be expected from this source. A more promising field, apparently, is the study of the natural factors that affect the normal fluctuations in insect infestations. Our lack of knowledge concerning these factors in the past has lessened the effectiveness of control projects because the beneficial insects were destroyed in the same proportion as the destructive barkbeetles, and because no account was taken of the effect of other natural factors.

The protection of both virgin stands and second growth depends on the use of natural enemies of the barkbeetles to the fullest possible extent and also on a knowledge of the factors that cause the increase and decline of infestations.

Considerable progress has been made in the study of the beneficial insects associated with the western pine beetle. The life history and habits and the importance under natural conditions of the most effective species have been carefully studied. We are now working on the application of the results of this study in control work. Slight modifications in control practice have already increased the value of the predators and as a result of our 1928 studies a more pronounced improvement in our methods of control is anticipated. The greater activity of the beneficial insects as compared with the bark beetles, and their habit of migrating at certain stages in their development has suggested means of encouraging the beneficial insects to escape from infested trees before the barkbeetles are destroyed by burning.

Experiments in summer control, without burning, have also given encouraging results. During the past summer trees were felled under different conditions of exposure and at different times according to the development of the broods, and the effects on both the western pine beetle and the beneficial clerids were studied. It was found that with ordinary felling methods, where infested logs were left in the woods for a week or two during the middle of the summer, a mortality of from 60 to 75 per cent of the barkbeetles were obtained, while less than 25 per cent of the clerids were killed. The western pine beetle larvae, being qite inactive, were not able to escape from unfavorable conditions, such as heat and excessive moisture or drying, and so were killed. The beneficial clerids being very active were able to crawl away to more favorable situations whenever necessary. This type of control should prove more effective than our present methods which destroy beneficial and destructive insects without discrimination.

Studies of the effect of fires, drought, windfalls, slash, and other factors which affect insect infestations are also of great importance in the protection of both virgin and second growth stands. A greater knowledge of the effects of the controllable factors such as slash and fires will make possible the prevention of many conditions which formerly caused serious outbreaks. An understanding of the effects of the non-controllable factors, such as windfalls and drought, will make it possible to predict what is likely to happen under certain conditions and thus time our control operations so that they will be of most value.

Although we still have much to learn about many of these interrelationships we do have fairly definite data on some of the factors under certain conditions. Any condition, such as drought or fire, which results in a lowering of the vigor and resistance of a stand favors bark-beetle epidemics. On the other hand, the accumulation of slash, which is often considered a serious menace, is seldom of more than secondary importance and if rightly handled may even result in a decrease in the surrounding infestation.

As the depletion of our virgin stands continues the importance of the protection of our cutover areas becomes more evident. In a study of the losses from insects on a number of these areas it was found that on the poorer, pure western yellow pine sites the insect losses often amounted to more than the growth. To prevent these excessive losses and make our second growth stands as nearly "insect proof" as possible we must know what trees are preferred by the beetles so that such trees may be removed in the first cut. The results of a study of the tree selection habits of the western pine beetle have just been reported. These Studies confirmed earlier studies as to the type of tree preferred by this beetle and also increased our knowledge of the factors affecting this selection. Briefly, the most susceptible trees are the slow growing, small-crowned trees which occur chiefly in certain recognized tree classes.

A better understanding of this whole problem depends on the determination of the underlying cause of this selection of certain trees. Preliminary work indicates that substances in the phloem or inner bark, or their fermentation products are the attracting agents. This work is being continued in order to more definitely determine what the attractive substances are and also what causes their presence in certain trees. This will give us a more logical basis for distinguishing attractive and non-attractive trees and should contribute to a better understanding of the causes of the increase and decline of western pine beetle infestations.

While the principle purpose of this tree selection and attraction study is to give us a more definite basis for selecting trees to be removed from areas being logged, it is also evident that if a strongly attractive substance can be found it would prove a valuable aid in bark-beetle control.

I have confined myself to the western pine beetle problem in western yellow pine stands. But as previously stated, this is not the only important forest insect problem in California. Because of limited funds and limited personnel it has been necessary to neglect other problems and concentrate on what we consider the most important one.

Studies on the fir insects, including both Douglas fir and the true firs are badly needed as are also studies on the so-called secondary engraver beetles which are especially destructive to second growth stands and in our recreational areas. The mountain pine beetle is causing heavy losses in our sugar pine and lodgepole pine stands and defoliators are assisting the barkbeetles by weakening the stands of many timber species. These and many other problems of almost equal importance need attention and will receive it as soon as funds and personnel are made available.

October 16, 1928

INTENSIVE STUDY OF RUNOFF OF A BURNED-OFF AREA

by

C. J. Kraebel
California Forest Experiment Station

This study is made of a small, steep mountain canyon, 177 acres in extent, adjoining Devil Canyon in the San Bernardino Mountains. It was burned over on August 31, 1925. In 1927 the California Forest Experiment Station, in cooperation with San Bernardino Water Department and other agencies, erected numerous rain gages and chronograph registers on this area, and built an impounding reservoir called Barranca Reservoir immediately below.

The mean slope of the area is approximately 2½ feet horizontal to 1 foot vertical or 40%.

The record consists of the storms of February and April, 1928. It was decided to use the chronograph showing stages of water in Barranca Reservoir alone for purposes of determining the inflow. The reservoir according to this chronograph has a seepage or absorption which must be considered in accounting for the water. The following table shows the calculated results:

Barranca Burn Reservoir

Water quantities in cubic feet

Date	Time	Storage: Beginning	Storage: End	Apparent storage	Absorption	Runoff during periods	Daily runoff
Feb. 3	10 A.M. to 1:45 P.M.	0	4	4		4	
	1:45-2 P.M.	2	8	6		6	
	9:30-9:45 PM	6	10	6		6	16

Date	Time	Storage: Begin-ning	Storage: End	Apparent storage	Absorp-tion	Runoff during periods	Daily runoff
Feb. 4	3:00-4:00 AM	10	15	5		5	
	4:00-5:00	15	2850	2835	230	3065	
	5:00-7:00	2850	2850	0	460	460	
	7:00-8:15	2850	9250	6400	290	6690	
	8:15-10:00	9250	11440	2190	400	2590	
	10:00-11:00	11440	11440	0	230	230	
	11:00 AM to 3:00 PM	11440	10400	0	1000	0	
	3:00 PM to 7:00 PM	10400	9500	0	900	0	
	7:00 to 11	9500	8800	0	700	0	
	11:00 PM to 12:00 M	8800	8500	0	300	0	13,040
Apr. 3	3:30 AM to 5:00 AM	0	10	10	0	10	
	9:30-10 AM	4	3250	3246	32	3278	
	10:00-11 AM	3250	3250	0	64	64	
	11:00- 6 PM	3250	2800	0	450	0	
	6:00-6:15PM	2800	3600	800	16	816	
	6:15-12 M	3600	3200	0	400	0	4,168
Apr. 4	12 M -6:00AM	3200	2800	0	400	0	
	6AM -12 M	2800	2600	0	200	0	
	12 M -6:00PM	2600	2400	0	200	0	
	6PM -12 M	2400	2200	0	200	0	0

This table shows:	For 177 acres sec. ft.	Per sq.mi. sec.ft.
Peak Feb. 4, 1928	3.5	12.6
Average Feb. 4, 1928	0.15	.5
Average Apr. 3	0.05	.18

On Devil Canyon the U.S.G.S.discharge shows:	For 6.3 sq.mi. sec. ft.	Per sq.mi. sec.ft.
Peak Feb. 4, 1928	---	---
Average Feb. 4, 1928	16.0	2.5

The amount of debris transported by the storm of Feb. 4, 1928, settled to 1726 cubic feet with a pore space of 50 per cent. The net solids were therefore 863 cubic feet and the net water 12,177 cubic feet, or 7 per cent and 93 per cent respectively of the total catchment of the reservoir.

The storm of April 3 transported 1210 cubic feet of debris with a similar pore space after settling. The net solids from this storm were 605 cubic feet and the net water 3563 cubic feet, or 14.5 per cent and 85.5 per cent respectively of the total catchment.

A given total precipitation during a storm or a season over a given watershed will not always produce the same total amount of run-off nor the same amount of erosion debris. Any attempt to predict probable run-off or erosion must consider numerous variables such as: amount and condition of vegetation and condition of surface soil (all affected greatly by fire, slightly by season), amount and kind of precipitation (rain or snow), intensity of precipitation, time interval since last previous precipitation. The intensity factor is probably the most potent, but, in the chaparral region at least, fire may so alter the vegetative mantle of a watershed that a storm of an intensity which would previously have produced insignificant run-off and no measurable erosion may, after a fire, result in considerable run-off and in destructive erosion.

Observations were begun on the Barranca watershed for the primary purpose of evolving a satisfactory technique for measuring torrential run-off and erosion. The first measurements were made during the third rain season after the area had been burned over. Consequently both the run-off and erosion recorded above were probably less, in proportion to precipitation, than they had been during the two years following the fire.

During the rain season of 1927-1928 there were only two "effective" storms, i.e., storms of sufficient intensity to produce measurable run-off at the canyon mouth and to deposit erosion-debris in the reservoir. That of February 3 and 4 brought a total rainfall of 3.35 inches over Barranca watershed in 31 hours and deposited most of the coarse-grained debris; that of April 3 brought a rainfall of 1.42 inches, redistributed the coarse material in the reservoir and deposited much fine material. The maximum rainfall intensity was one-half inch in one hour, between 7 and 8 A.M. February 4, and the maximum run-off rate lagged but 15 minutes behind this surge of the storm. This rapid concentration of run-off waters reflects the following conditions of the watershed: steep slopes, much bare rock and hard subsoil, scant vegetation, no vegetative litter on the steep soil surfaces, well defined drainage gullies formed by previous storms since the fire, and disturbance of exposed soil by animals and wind.

In contrast to this record, and indicative of the regulatory influence of chaparral on run-off and erosion, are general observations made during the same storms on adjacent small canyons, similar to Barranca except that their sparse cover of chaparral had not been burned within recent years. From these canyons there issued no coarse-grained erosion debris and the small amount of run-off came so slowly that it escaped at the canyon mouth, not over the surface, but underneath by percolation into the old debris-cone.

The California Forest Experiment Station proposes ultimately to extend the methods evolved on the Barranca area to a direct long-time comparison of run-off and erosion as related to rainfall on two chaparral-covered watersheds as nearly identical as can be found, but one of which will be left undisturbed and the other deliberately denuded by fire. From such a study it is hoped to determine quantitatively the role of the chaparral forest in the conservation of soil and water in southern California.

FOREST
CALIFORNIA/EXPERIMENT STATION

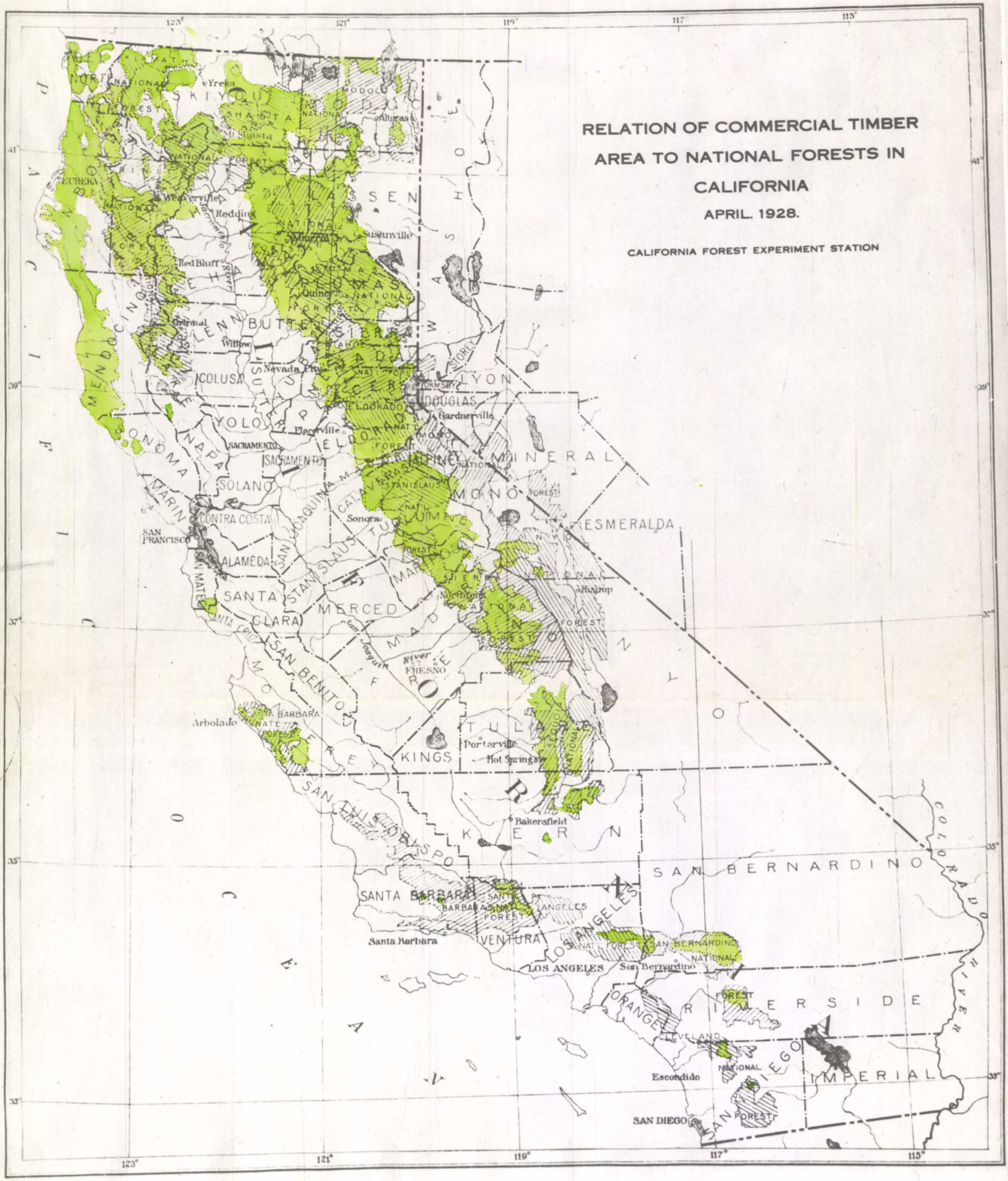
BRANCH STATIONS AND SAMPLE PLOTS
ESTABLISHED
TO
APRIL, 1928.

LEGEND

- CALIFORNIA FOREST EXPERIMENT STATION, BERKELEY
- BRANCH STATIONS
  - ① FEATHER RIVER
  - ② STANISLAUS CENTER
  - ③ DEVIL CANYON
  - ④ MT. SHASTA
- SAMPLE PLOTS

OREGON
PACIFIC OCEAN
NEVADA
MEXICO
Crescent City
KLAMATH NAT'L FOREST
Yreka
MODOC NATIONAL FOREST
SHASTA Mt. Shasta ④ NAT'L FOREST
Alturas
TRINITY NAT'L FOREST
Eureka
Weaverville
Redding
LASSEN NAT'L FOREST
LASSEN NAT'L PARK
Susanville
Red Bluff
PLUMAS N.F.
Quincy ①
CALIFORNIA N.F.
Willows
TAHOE NAT'L FOREST
Nevada City
Ukiah
Minden
ELDORADO N.F.
Placerville
SACRAMENTO
MONO NATIONAL FOREST
STANISLAUS N.F. ②
Stockton
Sonora
YOSEMITE NAT'L PARK
San Francisco
Berkeley
INYO
SIERRA NATIONAL FOREST
Bishop
North Fork
NAT'L FOREST
Santa Cruz
SEQUOIA GEN. GRANT NAT'L PARK SEQUOIA NAT'L PARK
Fresno
Monterey
SANTA BARBARA N.F.
Porterville
NAT'L FOREST
Bakersfield
San Luis Obispo
Mojave
Barstow
Needles
Ludlow
Cadiz
SANTA BARBARA NAT'L FOREST
ANGELES NAT'L FOREST
SAN BERNARDINO
Santa Barbara
Ventura
San Bernardino
Los Angeles
CLEVELAND NAT'L FOREST
NATIONAL
Escondido
El Centro
San Diego
Yuma

RELATION OF COMMERCIAL TIMBER AREA TO NATIONAL FORESTS IN CALIFORNIA

APRIL. 1928.

CALIFORNIA FOREST EXPERIMENT STATION